COOPERATIVE TESTS OF CHEMICAL INSECTICIDES FOR CONTROL OF THE DOUGLAS-FIR TUSSOCK MOTH

1973

Cover Photo: Bell 205-A applying insecticide.

COOPERATIVE TESTS OF CHEMICAL INSECTICIDES FOR CONTROL OF THE DOUGLAS-FIR TUSSOCK MOTH — 1973
(Mexacarbate, Trichlorfon, Carbaryl and Bioethanomethrin)

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1973 TESTS OF FOUR INSECTICIDES IN THE BLUE MOUNTAINS OF OREGON AND WASHINGTON - (MEXACARBATE, TRICHLORFON, CARBARYL AND BIOETHANOMETHRIN)

I. INTRODUCTION

In July of 1971, a serious outbreak of Douglas-fir tussock moth *(Orgyia pseudotsugata)* was discovered in several areas of central Washington. Subsequent aerial surveys determined that about 2,400 acres were affected with about 250 acres heavily damaged. Defoliator monitoring plots in the Blue Mountains of Oregon and Washington revealed subepidemic populations at the same time.

In June of 1972, the population in the Blue Mountains literally exploded. Total acreage infested by the end of 1972 in Washington and Oregon amounted to 197,000 acres of which about 15,000 acres were seriously damaged.

A comprehensive survey and evaluation of the outbreak indicated that some 449,000 acres of heavy defoliation could be expected in 1973 if the outbreak was not controlled. A National Environmental Policy Act (NEPA) Environmental Statement covering all possible management alternatives was prepared. DDT, which had been used successfully to control previous outbreaks, was not available for use because of the June 14, 1972 Environmental Protection Agency (EPA) Order cancelling almost all uses of DDT. Since no other insecticides were available that were known to be effective against the tussock moth, a specific request for the emergency use of DDT was made by the USDA-Forest Service to EPA on March 20, 1973. On April 20, 1973, the EPA denied the request. A test of four insecticides and two microbial agents, which had shown promise in laboratory tests, was conducted in the Blue Mountain outbreak area during 1973.

Because private landowners in the area requested assistance in saving their trees from the tussock moth infestation, it was decided after the DDT request denial to expand the Zectran test to include private land, when requested, on a cost sharing basis.

This report covers the planning, establishment and evaluation of all of the insecticide tests. During 1974, the Pacific Northwest Forest and Range Experiment Station will report separately on a series of microbial tests conducted.

II. TEST OBJECTIVES

The objectives of the insecticide tests were to determine if:

A. Any of the test insecticides would significantly prevent tree foliage loss and subsequent tree damage due to tussock moth infestation.

B. Any of the test insecticides would reduce tussock moth populations to an acceptable level.

C. Either mexacarbate or trichlorfon would be significantly more effective with a double application than a single application at the prescribed dosage rates.

III. HISTORY AND BACKGROUND

The Douglas-fir tussock moth is a native insect of western North America and has periodically caused extensive tree mortality in the coniferous forests of Canada and the United States.

The first recorded outbreak of the Douglas-fir tussock moth in Canada was in 1918 near Chase, British Columbia. The most recent infestations in Canada have been reported in 1971, 1972 and 1973 near Kilpoola Lake, west of Osoyoos, British Columbia.

The first report of the insect in the United States was on the Sierra National Forest, California, in 1906. In 1928-30, a severe outbreak developed in the Colville National Forest in northeastern Washington and was reported to have killed some 300 million board feet of commercial timber. Several other smaller outbreaks occurred in eastern Oregon, Idaho and California over the next 15 years until in 1944-47 an infestation in southeastern Washington, northeastern Oregon and western Idaho covered more than 500,000 acres. This outbreak was sprayed with DDT using 1 lb. of DDT in 1 gallon of fuel oil per acre. The results were reported as highly satisfactory.

Other outbreaks have occurred periodically throughout the West, including several in Nevada, Arizona and New Mexico. In 1963, a small infestation of 15 acres was discovered on the Malheur National Forest in Oregon. During 1964, this small outbreak had increased to some 40,320 acres on the Malheur and Ochoco National Forests. In 1965, about 65,000 acres were treated with DDT at ¾ lb. per acre in 1 gallon of fuel oil. This application was extensively monitored for effects on fish, wildlife and domestic livestock with no apparent ill effects reported.

Many other small outbreaks occurred about the same time in Oregon, Idaho, California, Montana, Arizona, and New Mexico.

In the Pacific Northwest during 1970, a few tussock moth larvae were observed during ground surveys throughout eastern Oregon, but no visible damage was noted. The only damage reported in Washington in 1970 was on shade trees in Spokane. In 1971, severe defoliation was noted at widely scattered locations in Washington near Cashmere, Riverside and Oroville. Egg surveys in the fall of 1971 near Riverside and Oroville indicated these populations would cause additional damage in 1972. Some 22,000 acres were actually defoliated to varying degrees in Washington during 1972. Scattered outbreaks were reported in Chelan, Douglas, Okanogan, Lincoln, Stevens, Ferry and Spokane Counties and on the Colville Indian Reservation.

During 1971, the tussock moth remained at subepidemic levels on the Umatilla, Wallowa-Whitman, and Winema National Forests in Oregon. In 1972, visible damage developed on 173,600 acres in the Umatilla and Wallowa-Whitman National Forests. The outbreak extended northeast 75 miles from La Grande, Oregon, into southeast Washington. The population on the Winema National Forest remained at the incipient level.

IV. BIOLOGICAL EVALUATION

Biological evaluation surveys were undertaken during the fall of 1972 in known Douglas-fir tussock moth activity centers and in adjacent areas of host-type timber. The primary objectives of these surveys were to: locate and delineate areas where the tussock moth was active; measure the density and trend of the moth population in these areas; and collect egg masses from which the incidence of a virus disease in the moth population might be determined.

The evaluation was a cooperative project involving personnel from the States of Oregon and Washington, Colville Indian Agency and Boise Cascade Corporation as well as Forest Service personnel.

EVALUATION RESULTS

Surveys indicated that about 90 percent of the nearly 200,000 acres visibly defoliated during 1972 was in the Blue Mountains. Of this total, about 15,660 acres (8%) had tree killing (Class I)[1] while 64,870 (33%) acres had top-killed trees (Class II). Several new tussock moth-infested centers were found in areas where no visible defoliation could be distinguished by the helicopter survey (Class III).

Virus incidence determination indicated an overall average of less than 1%, a percentage too small to prevent serious tussock moth damage in 1973.

V. SCOPE OF THE PROJECT

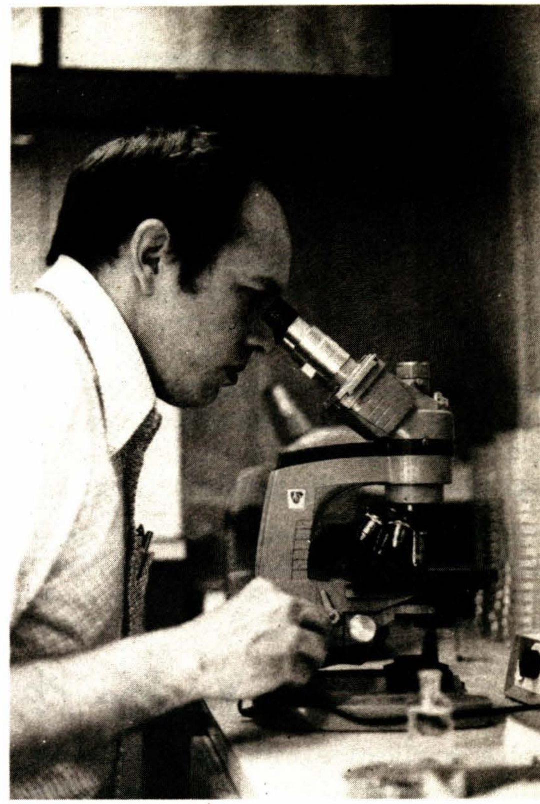
Topical application with laboratory tests conducted by the Insecticide Evaluation Project of the Pacific Southwest Forest and Range Experiment Station identified four chemicals with the most promising potential for large-scale field testing against the Douglas-fir tussock moth. Because of their short residual life, it was planned to test three of these chemicals at both the single and double application rate. However, one of these, Bioethanomethrin, was not available in enough quantity to test at more than the single application rate. The four chemicals tested and rates of application were as follows:

1. Mexacarbate (Zectran FS-15) @ .15 lbs./acre - 1 application
2. Mexacarbate (Zectran FS-15) @ .3 lbs./acre - 2 applications
3. Trichlorfon (Dylox) @ 1 lb./acre - 1 application
4. Trichlorfon (Dylox) @ 2 lbs./acre - 2 applications
5. Carbaryl (Sevin 4-Oil) @ 1.01 lbs./acre - 1 application
6. Bioethanomethrin (BEM) @ .01 lb./acre - 1 application

Airport tests of the chemicals to be field tested were conducted at Corvallis, Oregon, by personnel of the Aerial Application Project of the Pacific Northwest Forest and Range Experiment Station. Effective swath width, optimum nozzle size, nozzle orientation, speed of aircraft and pump pressure necessary to provide the desired droplet size spectrum of 150-170 microns, vmd were determined. These specifications were incorporated into all application contracts.

[1]See Table ~~8~~ 4 for damage class definitions.

Larval webbing on defoliated branch indicates heavy tussock moth feeding.



Douglas-fir tussock moth egg masses indicate probable damage from defoliation in 1973.

A field laboratory to determine the incidence of virus in the population was set up in La Grande, Oregon.

A study plan was developed for each individual insecticide test by personnel from Region Six, Pest Control; the Aerial Application Project, Corvallis; and the Insecticide Evaluation Project, Berkeley. These plans included organization, test objectives, experimental design, procedures, manpower requirements, equipment needs, cost estimates and the data analysis and reporting procedures to be used. They were reviewed and approved in advance by all participants.

In addition to experimental testing of these chemicals, Zectran was applied twice at the rate of .15 lbs. /acre each application to a total of 70,496 acres (see Table 6).

VI. STUDY DESIGN

Each chemical was tested at four independent geographic outbreak areas with a complete randomized experimental design replicated three times at each location. There were three treatments evaluated using mexacarbate and trichlorfon and two treatments evaluated using Bioethanomethrin and carbaryl. Treatments tested for each chemical at the application rates listed above were as follows:

Mexacarbate (Zectran) test

Code	*Treatment*	*Replications*
1	single application	3
2	double application	3
3	untreated check	3

Trichlorfon (Dylox) test

Code	*Treatment*	*Replications*
1	single application	3
2	double application	3
3	untreated check	3

Bioethanomethrin (BEM) test

Code	*Treatment*	*Replications*
1	one application	3
2	untreated check	3

Carbaryl (Sevin 4-Oil) test

Code	*Treatment*	*Replications*
1	one application	3
2	untreated check	3

PLOT SELECTION AND SIZE

1. All test areas were located within the tussock moth outbreak area in Oregon and Washington (see maps in Appendix).

2. Each test area contained a relatively high tussock moth population. In order to determine this, an egg mass density survey was conducted by sampling two mid-crown branches from each of 25 trees within the potential test blocks. Egg mass counts per 1,000 square inches of foliated branch were required to average one or more in order to be selected for study blocks.

3. One egg mass was collected from each of the 25 trees sampled for egg masses and reared to determine the virus incidence in each proposed study block. A virus incidence greater than 5 percent prohibited the use of an area as a study block. In almost all cases, virus percentage was less than 1.0 percent in study blocks. Virus determinations were made at the La Grande laboratory of the Pacific Northwest Forest and Range Experiment Station by Region 6 entomologists with assistance from Dr. Clarence Thompson of the Pacific Northwest Forest and Range Experiment Station at Corvallis. Alternative blocks were located in case some study blocks could not be used.

4. Study blocks were widely dispersed so some data could be secured in case a population collapse should occur in any one area and to minimize contamination from treatments on nearby spray blocks.

5. Study blocks varied in size from 105 acres to 600 acres with the average about 400 acres. Plot size was chosen to be large enough to resemble operational conditions yet small enough to be quickly and adequately sampled. The shape of plots was selected to provide swath runs of sufficient length to allow rpm stabilization of the spray equipment and sufficient area width to allow for spray turbulence, drift and settling within the treated areas. Treatments were randomly assigned to the blocks.

SUBPLOT SELECTION

1. Four clusters of 10 trees each were located in each study block in as random a manner as possible consistent with accessibility, general coverage and how well it represented the area. Five clusters of 10 trees each were used for the BEM study.

2. Each cluster was made up of 10 trees selected for population sampling and general study. Sample trees were chosen that could be sampled in mid-crown by a 24-foot extendable pole pruner equipped with a cloth basket just below the cutting head. Sample trees were numbered consecutively from 1 to 40 for each study block regardless of cluster, with the exception of the BEM study where trees were numbered from 1 to 50.

3. The first application on double application plots of Zectran and trichlorfon was made 3 days after 60 percent of the egg masses had started to hatch. The second application was made approximately 10-14 days later.

The single application of all chemicals was made when 90 percent of the egg masses had started to hatch.

POPULATION SAMPLING

Tussock moth larval population sampling method used was developed by Mason[2] for egg and larval sampling with an adjustment in numbers of branches per tree to accommodate changes in relative variance between prespray and postspray population samples. Population sampling was as follows: Four branch samples, each approximately 15 inches long were cut from the mid-crown of each sample tree during the prespray and eight branch samples during the postspray sampling periods. The tussock moth and other insect larvae from each tree were counted and the total number recorded on the data forms. The length and width of the foliated portion of the branch sample were measured to the nearest half-inch. The total number of buds or shoots of the current year were counted on each branch and damage class was determined for each shoot.

Chemical tests using mexacarbate (Zectran) and trichlorfon (Dylox) were sampled six times to determine treatment effectiveness. Each insecticide was tested independently using a single and double application of insecticide. The first larval sampling was started 2 days after 60 percent of the egg masses started to hatch. This was followed by three additional early instar sampling periods at 5-day intervals (see Table 1). The chemicals were applied 1 day after the first and third larval sampling periods in the double application test. In the single application test, the chemicals were applied 1 day after the second sampling period.

[2]Mason, Richard R. 1970. Development of sampling methods for the tussock moth, *Hemerocampa pseudotsugata* (Lepidoptera: Lymantriidae). Can. Ent. 102(7): 836-45 Illus.

Chemical tests using carbaryl (Sevin 4-Oil) and Bioethanomethrin (BEM) were sampled five times to measure the effectiveness of a single application. The first larval sampling was made 2 days after 90 percent of the egg masses started to hatch. The chemical was applied 1 day later. Postspray early instar samples were made 4 days after treatment and again 14 days after treatment. The final larval population sample was taken in July and August just prior to pupation, using the same methods as for the prespray and postspray samples. A foliage retention assessment was also made during the prepupal examination. Population sampling was completed on all plots when an egg mass density survey was completed in September.

Table 1.—*Schedule used for coordinating insecticide application and population sampling with insect development*

Mexacarbate (Zectran) and Trichlorfon (Dylox) Test

Treatment[1]	Sampling Periods 1st day 1	day 2	2nd day 6	day 7	3rd day 11	day 12	4th day 16	5th days 28-44	6th Sept.
Double application	LS[2]	S	LS	O	LS	S	LS	LS	EMS
Single application	LS	O	LS	S	LS	O	LS	LS	EMS
Check	LS	O	LS	O	LS	O	LS	LS	EMS

Carbaryl (Sevin 4-Oil) and Bioethanomethrin (BEM) Test

Treatment	Sampling Periods 1st day 1	day 2	2nd day 6	3rd day 16	4th days 28-44	5th Sept.
Spray	LS[2]	S	LS	LS	LS	EMS
Check	LS	O	LS	LS	LS	EMS

[1]Larval sampling was started 2 days after 60 percent of egg masses had started to hatch for chemical test where a single and double application were evaluated; and 2 days after 90 percent of egg masses started to hatch when only a single application of insecticide was to be evaluated.
[2]Symbols denote action taken: LS, larval sample; S, spray; O, untreated; EMS, egg mass sample.

SPRAY DEPOSIT ASSESSMENT

Assessment of spray deposit was carried out, using foliage, aluminum plates and Kromekote cards. The basic deposit sampling consisted of four 15″ branches taken from mid-crown, two aluminum plates (6″ × 6″) and one white Kromekote card at each sample tree. The plates and cards were positioned in wire holders about 1 foot above ground level in the nearest open area adjacent to each sample tree.

The plates and cards were placed in the field the day before spraying. Within 4 hours after spray application, the pairs of plates and the cards were collected and stored.

The four foliage samples removed from the tree for pretreatment insect mortality counts were used for the pretreatment foliage assessment samples. One hundred needles chosen at random were removed from each of the four foliage samples and placed in opaque paper bags.

The foliage samples removed post-treatment for insect mortality counts could not be used for spray assessment because they are not removed until 72 hours after spraying, in which time the dye would fade. It was, therefore, necessary to take a second set of four foliage samples from the sample trees within 3 hours after spraying. These samples were collected from the four cardinal directions at mid-crown. They were then sent to the Aerial Applications Project (AAP) at Corvallis, Oregon, along with the prespray samples, for assessment.

The assessment of the cards, plates and foliage samples collected after treatment was done by AAP.

ASSESSMENT OF EFFECTS ON NONTARGET INSECTS

Collections of insects from drop boxes placed beneath selected study trees were examined for parasites and predators associated with the Douglas-fir tussock moth. These collections were assessed by Mr. Patrick Shea of the Insecticide Evaluation Project and a separate report on this study will be made by the Pacific Southwest Forest and Range Experiment Station, Berkeley, California.

ASSESSMENT OF FOLIAGE RETENTION

Defoliation assessments were done in two ways:

1. A whole tree visual classification of defoliation and damage[3] was recorded on forms provided by the Insecticide Evaluation Project. This assessment was made when the trees were selected for each cluster and again when the prepupal larval survey was made.

2. Each new (current year) shoot on the 15-inch sample twigs collected at each larval sampling period, and the current year's shoot on the entire branch collected during the egg mass sampling period were counted and placed in the following categories: Undamaged (0-25% defoliation), partly damaged (26-75% defoliation) and severely damaged shoots (76-100% defoliation). These counts were tested to determine if they varied significantly by area for each sampling period.

AERIAL PHOTOGRAPHY

It was planned to take before and after aerial photographs of each study plot with Kodak Ektachrome Infrared Aero film, type 2443, at two scales: 1:15,840; 1:4,000 during early May before defoliation occurred and late July or August when the tussock moth had completed feeding and the defoliation is most conspicuous. However, due to shortage of time, the prespray photos were not completed and the plots were not photographed until September and October. These photos were examined in stereo to determine areas of foliage protection, degrees of defoliation and zones of spray drift in relation to spray blocks, in accordance with procedures described by Ciesla et al.[4] Preliminary results from aerial photographs indicate no visible difference in treated and untreated areas. A separate report will be prepared on this phase of the evaluation at a later date.

VII. ENVIRONMENTAL MONITORING

When DDT was being considered for control of the tussock moth, an interagency committee was formed to develop a monitoring plan to check the effect of DDT on the various phases of the environment. When the use of DDT was denied, the committee revised its plans to cover the four insecticide tests within the resources available to them. As a result of this change, it was decided to monitor primarily those chemicals about which little was known, except in the case of water quality. Water quality was to be monitored for as many chemicals as practicable. Following is a summary of these monitoring efforts:

WATER QUALITY

This monitoring activity was carried out by the Oregon State Department of Environmental Quality. Since the majority of the chemical test plots were on dry ridges, in some cases it was difficult to find adequate water sources to monitor and in other cases where water sources were available for the prespray samples, they had dried up before the postspray samples were ready to be taken.

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[3]Williams, Carroll B. 1967. Spruce budworm damage symptoms related to radial growth of grand firs, Douglas-fir and Engelmann spruce. Forest Service 13(3): 274-285.

[4]Ciesla, W.M., et al. 1971. Color Photos, aerial sprays and the forest tent caterpillar. Photogrammetric Eng. 37: 867-873.

No water quality data are available for Dylox or Bioethanomethrin because the water sources on these plots dried up too early. Effects of Zectran were minimal except that on one plot in the Perry area near La Grande, there was a reported estimate of 75 percent aquatic insect mortality. The area made a good recovery in about 3 weeks, probably through drift of aquatic larvae from upstream, unsprayed areas. Other plots indicated little, if any, effect on aquatic organisms and no plots indicated a more than normal amount of chemical in the water.

Effects of carbaryl were measured at a pond within one spray plot. This pond had abundant frog tadpoles before spraying. They had disappeared after spraying, but no dead tadpoles were found. Again, the water showed no abnormal amounts of the insecticide in the sample tested.

In all areas sampled, the pesticides were less than the detection limits of the specific analysis.

SMALL MAMMAL POPULATIONS

Monitoring of small mammal populations was carried out by the Oregon State Health Division. Monitoring consisted of checking population densities of deer mice, *Peromyscus maniculatus*, before and after applications of trichlorfon. This project was carried out by trapping the deer mice before and after spraying and checking differences. The conclusion was that "there was no evidence of major population reduction in *Peromyscus maniculatus* following applications of trichlorfon at the rate of one pound of active ingredient per acre."

In addition to the study on deer mouse populations, samples of chipmunks were sent to the Oregon State Department of Agriculture laboratory for analysis of trichlorfon in the carcasses.

The analysis was made by gas chromatograph with the following results: "None of the chipmunks analyzed gave any measurable gas chromatographic peaks, leaving three probable conclusions: (1) Dylox (trichlorfon) was not picked up by the chipmunks; (2) Dylox changed to an undetectable metabolite; (3) Dylox was for some reason not detected."

A more detailed analysis of each of these monitoring efforts may be found in separate publications prepared by the agencies involved.

BIRD POPULATIONS

Monitoring of bird populations was done by the U.S. Bureau of Sport Fisheries and Wildlife in the trichlorfon test area. The monitoring consisted of collecting birds and checking the amount of acetyl cholinesterase enzyme (AChE) in the brains of these birds. Results indicate that there was no serious depression of brain AChE activity in the species checked. Species checked were the Oregon junco, mountain chickadee, and Audubon's warbler. Observation of other species on or adjacent to the plots, including singing habits, indicated that "birds were not seriously affected by spraying of trichlorfon in a single application or by two 1.0 lb./acre applications at about 2-week intervals."

AQUATIC POPULATIONS

The monitoring of aquatic populations sprayed with Bioethanomethrin was carried out by the Bureau of Sport Fisheries and Wildlife. Test areas were installed at each of the three spray plots to check effects on aquatic insects and fish. Conclusions were that "drift of aquatic invertebrate organisms occurred within 10 minutes after the spray made contact with the water. Numbers of drift organisms increased over a 1-hour period and then declined rather rapidly. Although the invertebrate loss was high in the spray area and immediately downstream, the compound toxicity was short-lived. Bottom fauna in the stream 1½ miles below the point of application appeared to be unaffected. No fish loss was observed as a result of spraying in any of the plots. Regardless of the fact that there was no fish loss, the use of Bioethanomethrin in streams containing resident fish populations could cause a reduction in the invertebrate population to a point where fish would be forced to abandon an area or face starvation."

Environmental monitoring carried out on the 1973 insecticide tests should provide a good background for further monitoring.

VIII. OPERATIONAL ASPECTS

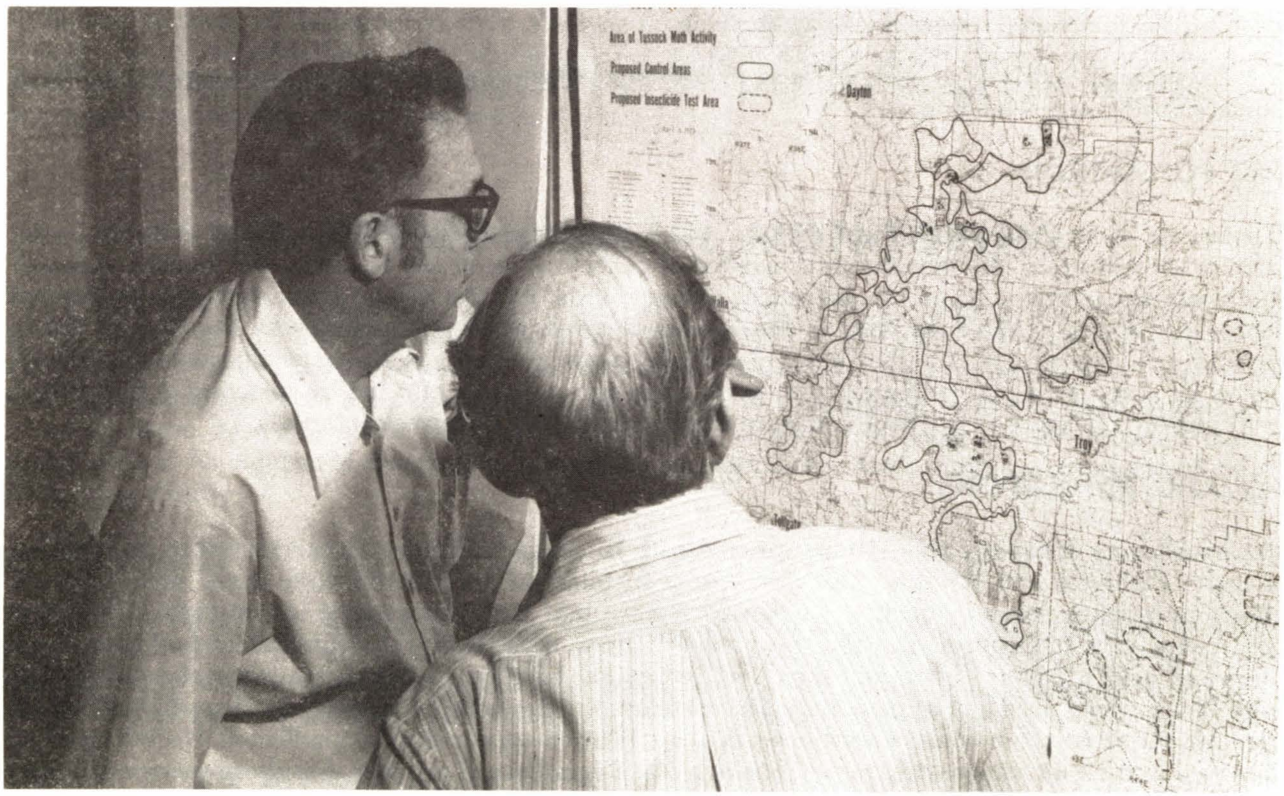
PLANNING

Initial spray headquarters was set up in La Grande, Oregon. The Oregon State Forestry Department furnished a building to be used for offices and storage of equipment. The first project personnel to occupy the headquarters were the unit supervisors and their crews. Their preliminary job was to locate the test plots in host-type areas that were accessible to roads and had an insect population and mark the plot boundaries. The Bioethanomethrin plots were located in the northern Blue Mountains south of Pomeroy, Washington, and due to the distances involved, the test supervisor for this test established headquarters at the Pomeroy Ranger Station. With the exception of the test supervisor, the assistant test supervisor and, at a later date, a few crew members, the crews of the Bioethanomethrin test were all hired by the State of Washington.

The Dylox test was handled entirely by the State of Oregon Department of Forestry personnel. The test supervisor, who is the State forest entomologist, was under the overall supervision of the project director.

The Zectran and carbaryl tests were supervised by Forest Service personnel but many of the crew members were hired by the State of Oregon.

During the project, when it was determined that spraying of the Walla Walla watershed would be included, a headquarters was set up at the Walla Walla Ranger Station to handle the watershed spraying. The Zectran mixing contractor also set up a mixing plant in Walla Walla. The La Grande and Walla Walla headquarters were operated simultaneously until all private land spraying was completed, at which time the La Grande headquarters was shut down.



Planning sessions for each test application were carried out at spray headquarters in La Grande, Oregon, and later in Walla Walla, Washington.

PERSONNEL

At the peak of the project, there were 107 personnel employed on the insecticide tests. Of these, 28 were furnished by the State of Oregon, 16 by the State of Washington, 8 by the Umatilla National Forest, 24 by the Wallowa-Whitman National Forest, 5 by the Cave Junction Smokejumper Base, 4 by the North Cascades Smokejumper Base, 1 unit supervisor from Region 4, 17 from the Regional Office of Region 6, 1 I&E officer from the Okanogan National Forest, 1 air officer from Region 4, and 2 from the Pacific Southwest Forest and Range Experiment Station.

During the project, there were numerous personnel changes. The smokejumpers, who were primarily used as crew leaders, had to return to their bases for training and new crew leaders had to be found. Later in the project, several people had to return to their home units because of personnel shortages in their regular jobs, and several personnel either quit or were fired for not showing up for work. Collection of information requested by research personnel required expansion of crews during the project and as some phases of the work were completed crews were reassigned to other jobs.

When the aerial spraying project was completed, all crews were returned to their home bases or laid off, with the exception of the laboratory technicians. Many of them, as well as some new ones, were brought back for the prepupal sampling in July and August.

EQUIPMENT

A total of 44 vehicles were used on the project. Of these, 12 were commercial pickup rentals provided by the Umatilla National Forest, several personnel used their personal vehicles on a mileage basis, 7 were furnished by the State of Oregon, 8 were furnished by the State of Washington, and the balance were from the GSA motor pools in Portland and Vancouver.

A 2,200-gallon tank truck was borrowed from the Equipment Development Center, at Missoula, Montana, for mixing of the dye with the Zectran to be applied to the small test plots.

A 150-gallon slip-on unit was borrowed from the La Grande District of the Wallowa-Whitman Forest to be used for water supply at helispots in case of an insecticide accident and to keep the dust down on the helispot. A 50-gallon slip-on unit was borrowed from the Pendleton District of the Umatilla Forest and a 300-gallon Harodyke tank from the Walla Walla District for the same purpose.

A forklift truck was furnished by the La Grande Smokejumper Base for loading and unloading barrels of Zectran. Occasional use was made of a forklift truck furnished by the La Grande District of the State Forestry Department for the same purpose.

A description of equipment for sampling on the insecticide plots is described in the individual test section of this report.

Radios for the project were furnished by the Umatilla and Wallowa-Whitman Forests. The Bioethanomethrin test was furnished with Umatilla frequency radios since they were operating primarily on the Umatilla Forest. The Zectran and carbaryl tests were furnished with Wallowa-Whitman frequency radios since they were operating on or adjacent to the Wallowa-Whitman Forest. Since the Dylox test was conducted by State of Oregon personnel, State radios were used for communications. Communications between the State and the other test supervisors were maintained through the base station radios which were on the same compound. Each test supervisor, weatherman, helispot manager and observation helicopter was furnished with a radio. In addition, the safety officer and, at times the project director, had radios.

Radio communications were vital to the entire project.

CONTRACTS

Because of the late start in planning the testing of four insecticides, contracting for helicopters was late for this project and many helicopters that would normally have been available were committed to other contracts. As a result, there was only one bidder (Evergreen Helicopters) on the major contract and the bid was only on a portion of the bid items. The contract called for 1 Bell 205-A helicopter for private land Zectran spraying and 1 Bell G3 B1 or equivalent for spraying the Zectran plots as well as 1 Bell G3 B1 or equivalent for observation on the Zectran plots. Evergreen Helicopters of McMinnville, Oregon was the only bidder on these items. On the same contract, there were bid items for spray and observation helicopters for the other three insecticide tests. There were no bidders on these items. It then became necessary to negotiate contracts with six small helicopter companies to obtain helicopters for the other three tests. A breakdown of contractors and bid prices is as follows:

Project	Type Aircraft	Contractor	Rate/hours
Extended Zectran Test-Spray	Bell 205A	Evergreen Helicopters	$2,750 - 1st 20 hours $1,400 - remainder
Extended Zectran Test-Spray	Bell 205A	Evergreen Helicopters	$1,400 until June 29 $1,200 thereafter
Zectran plot spray	Hiller 12E	Evergreen Helicopters	$ 350
Zectran plot - observation	Hiller 12E	Evergreen Helicopters	$ 185
Extended Zectran Test - observation	Bell G3 B-1	Cascade Helicopters, Inc.	$ 165
Dylox - Spray	Bell G3 B-1	Mountain Air Helicopters	$ 175
Dylox - observation	Bell G3 B-1	Albany Airways	$ 135
Carbaryl - spray	Bell G3 B-1	Helicopter Services Inc.	$ 225 + $200/day
Carbaryl - observation	Bell G3 B-2	Grote Aviation	$ 140
Extended Zectran Test - spray	Bell G3 B-1	Mountain Air Helicopters	$ 190
Bioethanomethrin - spray	Bell G3 B-1	Snake River Helicopters	$ 135
Bioethanomethrin - observation	Bell G3 B-1	Cascade Helicopters, Inc.	$ 155
Extended Zectran test - observation	Bell 206	Boise Cascade Corp.	$ 200 (under fire contract)

This Bell 205-A helicopter is capable of carrying 250 gallons of insecticide. Average hourly production was almost 900 acres treated.

All contract helicopters received $200.00 per day for days when they were required to be ready to work but no spraying was done because of weather, or because insects were not at the proper stage of development. On several days, a helicopter was rented from Rambling Rotors in La Grande when contract helicopters were not available because of breakdowns, 100-hour checks, or fires. The rate for their Bell G3 B1 was $145/hour.

Production and costs for helicopters will be found in Tables 6-10 of the Appendix. Significant features of spray contracts were:

1. Contractor to provide helicopters for spraying insecticides as part of an operational test.

2. Payment to be on an hours and minutes of flight time basis.

3. Each spray helicopter to be accompanied while spraying by a Forest Service observer traveling in an observation helicopter.

4. Contractor to provide transportation for insecticide from La Grande, Oregon to all helispots he uses.

5. Spray application to be made at an average airspeed of 45 miles per hour except for the 205A helicopter which was to fly at an average airspeed of 90 miles per hour.

6. Contractor to furnish 500-gallon tank truck for each spray helicopter, equipped to mix spray solutions by agitation or recirculation. Each tank truck to include pumps, hoses and metering devices.

7. Forest Service to provide mixing and storage of Zectran under separate contract with the exception of the Zectran formulation to be mixed with dye and used on the small Zectran test plots which was to be formulated in a Forest Service mixer tank by Forest Service personnel.

8. Small helicopters to provide tanks with a capacity of 60 gallons of spray solution. Large helicopters to provide tanks with a capacity of 400 gallons.

9. Booms to be at least 25 feet in length, preferably 30 feet or longer and capable of holding 22 American Systems spray jet nozzles with No. T-8003 orifice tips. Nozzles were to be spaced evenly along boom with at least 8 inches between nozzles. Boom to be capable of adjustment so all nozzles could be pointed forward and down 45° to the thrust line in flight of the helicopter. Operating boom pressure was to be 60 p.s.i. plus or minus 5 lbs.

10. Swath widths to be determined by calibration before spraying; otherwise they would be considered to be twice the boom length.

11. No spraying was permitted within one swath width of any major fish-bearing stream. Flights were to be made parallel to these streams.

12. All observation helicopters were required to be equipped with the necessary equipment to handle a Forest Service portable forest net-type radio integrally.

13. All helicopters to be paid a minimum of $200.00 per day if ordered to have men and equipment available for duty, and helicopters, personnel and supporting equipment are present and ready to perform. Flying time was to be applied against the daily minimum.

14. Basis for payment to the formulator was gallonage delivered to tank trucks for delivery to helispots.

15. The formulator's responsibility ended when insecticide was pumped into aerial spray contractor's tank trucks.

16. The formulator was required to have finished insecticide on hand and ready for use in the amount of 10,000 gallons at least every third day at La Grande. At Walla Walla, he was required to have 40,000 gallons available every third day.

The large Bell 205-A helicopters were capable of spraying small areas with great accuracy.

Accurate records were kept of insecticide mixed and loaded into aerial spray contractor's tank trucks.

MARKING OF SPRAY AREAS

Because of the scattered nature of the test spray plots, it was necessary to mark them in such a way that the boundaries were identifiable from the air. It was even more important in the case of small private land parcels adjoining areas that were not to be sprayed.

Marking was done by use of fluorescent orange marking cloth of the type used by smokejumpers to mark landing areas. Rolls of material were cut into 3′ × 3′ or 4′ × 4′ squares. These squares were then placed on the ground in openings at the plot corners. Test plots were laid out so that corners generally were in openings so marking could be seen. In the case of private land corners, markers were put along the line wherever they could be seen. Fence lines, cutting lines or other evidence of boundaries were used whenever possible. The small private land holdings were flown with observers from the States involved who were familiar with the ownership boundaries, to prevent errors in identification.

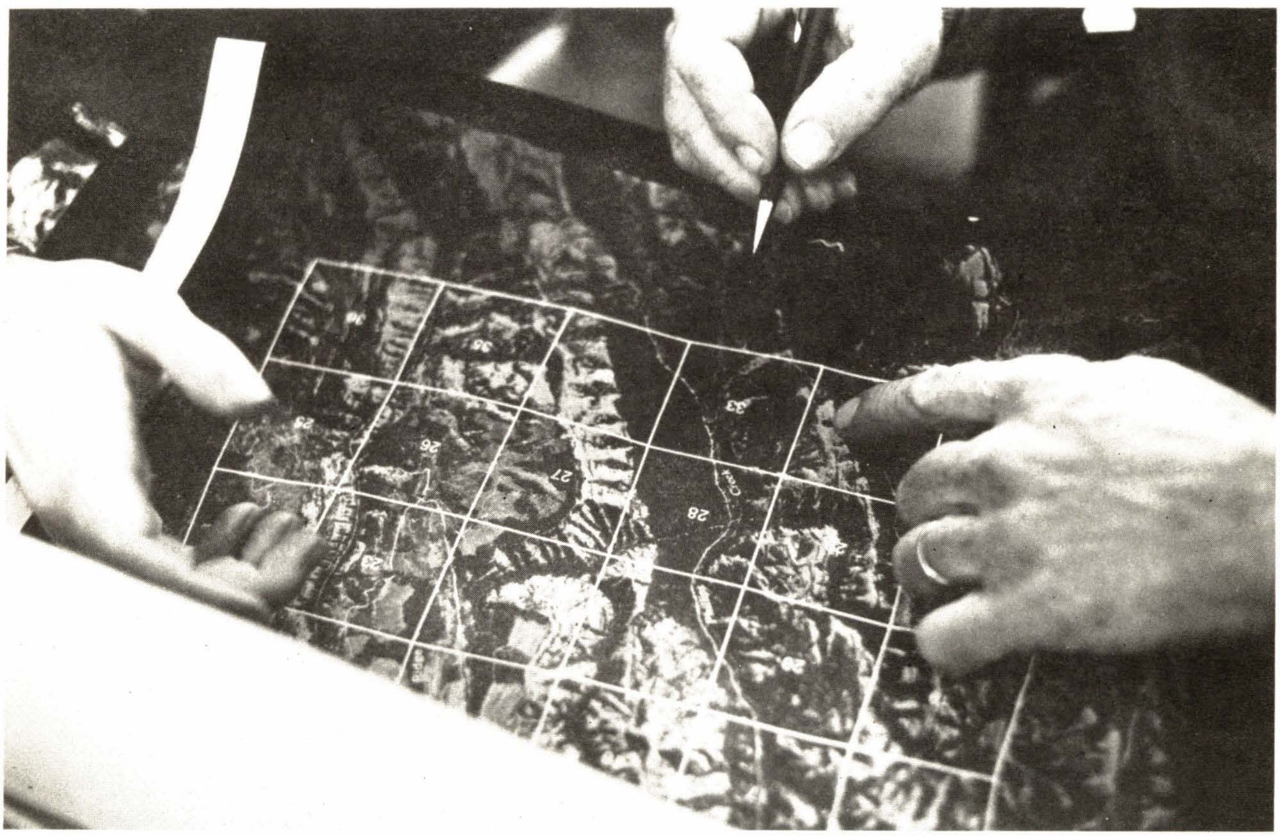
Ownerships less than 10 acres in size were not accepted for spraying unless they could be blocked up with other ownerships to make identification easier and accurate spraying possible.

SPRAYING

A total of seven spray helicopters and six observation helicopters were used on the project. The helicopters and average load capacities for the spray ships are as follows:

TYPE	*AVERAGE LOAD CAPACITY*
Bell 205A (2)	250 gallons
Hiller 12E (1)	60 gallons
Bell 47 G3-B1 (4)	70 gallons
Hiller 12E (1)	Observation
Bell 47 G3-B1 (3)	Observation
Bell 47 G3-B2 (1)	Observation
Bell 206B (1)	Observation

Each helicopter was inspected by the project air officer before use on the project. The only major problems noted were in the spray systems. Later in the project some radio problems developed in two of the spray helicopters.



Aerial photos were used to delineate areas that should not be sprayed because of lack of timber or environmental sensitivity.

Calibration of spray systems was done on each ship before spraying began and at intervals during spray operations. Calibration called for 60 lbs. pump pressure for all tests. Nozzle size was T-8003 flat atomizing teejet on all ships except the Bell 205-A's. Because of their greater speed, they were equipped with T-8020 nozzles, providing essentially the same droplet size.

Nozzle size and swath widths for the 205-A were determined at a special test carried out by the Aerial Application Project of the Pacific Northwest Forest and Range Experiment Station at Corvallis sometime before the project began. Effective swath width for these ships was determined to be 200 feet.

All other spray helicopter swath widths were determined at time of calibration and varied from 60′-100′ depending on boom length and chemical used.

No starting date was planned other than late May or early June. Starting date was contingent on egg hatch and spraying actually started on June 5 in the Perry area on private and Oregon State Highway Department lands near La Grande, Oregon. Spraying continued on small private land ownerships at the base of Mt. Emily on June 6 and June 7. On June 9, spraying commenced on the large block of land belonging to the Boise Cascade Corporation. This was also the date the first small test plot was sprayed. A Bell G3-B1 sprayed a 300-acre plot near Hoodoo Ridge Lookout with carbaryl. The first small Zectran test plot was sprayed on June 11, the first Dylox plot on June 10 and the first Bioethanomethrin plot on June 14.

Because each helicopter had bid on only one test area and could not be used on other areas, it was necessary to pay a considerable amount of standby time when egg hatch did not permit spraying for extended periods of time. For instance, the first and second carbaryl plots were sprayed on June 9 and June 10, but the third plot could not be sprayed until June 23 because of inadequate egg hatch. This increased the cost of the test considerably.

One of the major problems in completing this project was the relatively short spraying time available in each day. Even under ideal conditions, spraying could not be done beyond 9 or 10 a.m. because of the tendency of the spray particles to hang up or rise. On most days, spraying was shut off by 7 or 8 a.m. Because of this, a special effort was made to get all aircraft in the air just as soon as light conditions permitted safe operation. In some cases, this meant the ships were airborne as early as 4:45 a.m. The average length of spraying time per day for the project was about 2-½ hours.

Location of helispots was somewhat of a problem on this project. The large 205-A helicopters required much larger helispots than the small helicopters. They also required a longer takeoff run and a good dropoff. Because of this, helispots were rather far apart, necessitating longer ferries and more deadheading than originally planned. It also was necessary to water down many helispots because of the dust caused by the larger rotors on the 205A. In addition, it was necessary to have a crew fall many trees at the helispots to provide adequate takeoff and landing clearance. Some of this was due to the fact that the contractor used a pilot on one 205A who was inexperienced in forest spraying.

Much of the Walla Walla watershed area was virtually roadless and helispots had to be located on the periphery of this area. This increased the ferry distance from helispot to spray area. Maximum ferry distance for the project was about 7 miles with an average of about 3½ miles. This increased the flying time per acre sprayed and thus the cost per acre.

A gross total of 77,580 acres was treated, of which 70,720 acres were given a double application, giving a total of 148,300 acres on a single application basis. Zectran was applied to 73,234 acres, 1,697 acres with trichlorfon, 1,549 acres with Bioethanomethrin, and 1,100 acres with carbaryl.

COSTS

The costs of the extended operational test of Zectran was shared by the U.S. Forest Service and the landowners. The cost of the individual insecticide tests was paid for by the Forest Service. The total cost to the landowners for a double application of Zectran to their property was $144,236 or $3.75 per acre. This total does not include costs for monitoring, public relations, salaries for permanent Insect and Disease Control personnel or nonexpendable property items.

Total expenditures for the entire project were $739,555. A detailed summary of costs is shown in Table 5 of the Appendix.

SAFETY

Considering the number of flight hours, much of it over very steep rugged topography, and the number of man-days worked and vehicle miles driven, most of them under hazardous working conditions, the safety record for the project was excellent.

There were three insecticide loading accidents, two of which involved the same employee of one of the contractors. In the first accident, he was sprayed with Zectran when he pulled the loading hose loose while it was still under pressure. He was washed down immediately with water and rushed to the La Grande Hospital by helicopter. Next, he was doused with insecticide when a malfunction of the hose locking mechanism occurred. In this instance, his protective clothing prevented the Zectran from reaching his skin. He apparently suffered no ill effects either time. The third accident occurred during the carbaryl test when a loading hose from the tanker broke and sprayed insecticide on two men. They washed off and changed their clothing and had no ill effects from the accident.

There were four vehicle accidents, three of which were minor in nature. One accident which happened on the main street of La Grande, Oregon, resulted in a claim for almost $1,000 from the nongovernment driver when the government driver hit a small sportscar while making a left turn at a signal. No injuries were involved in any of the vehicle accidents.

Before the project began, a comprehensive safety plan was written and copies given to all personnel involved in the project. Safety talks were held regularly by supervisors, and most project personnel were very safety minded. Due to these factors and good cooperation from all concerned, there were no serious accidents or injuries on the project.

COOPERATION

Cooperation was the key word on this project. The State of Oregon conducted the trichlorfon test in its entirety except for the contracting. They also contacted landowners to determine if they wished to be involved in the program and had them sign requests to do so. They provided personnel to work with Forest Service crews on the carbaryl and Zectran tests, and they provided personnel to assist in locating, marking and observing in the spraying of small private land ownerships.

The State of Washington provided crews to work on the Bioethanomethrin test and the carbaryl test, as well as contacting landowners for involvement in the program.

The Pacific Northwest Forest and Range Experiment Station provided test information on the 205A helicopter, technical information for surveys, spray deposits, sampling, office space at the La Grande laboratory, and much other technical assistance.

The Pacific Southwest Forest and Range Experiment Station provided technical information on sampling, data compilation, data assessment, laboratory methods and other technical assistance.

Other divisions in the Regional Office, R-6, provided technical assistance in their individual fields. The Division of Range and Wildlife Management provided coordination with other agencies in the monitoring program for the project. The Division of Fire Management provided assistance in inspection of helicopters, pilots, and other air operation activities.

The following agencies assisted in monitoring of water, fish, birds, aquatic insects and other environmental factors for the various chemical applications:

Bureau of Sport Fisheries and Wildlife
Oregon State Department of Health
Oregon State Department of Environmental Quality
Oregon State Wildlife Commission

Region 4 provided an entomologist to head up the carbaryl test and assist in other phases of the operation. The Boise Interagency Fire Coordination Center provided an air officer for the project to assist in all phases of the aerial operations.

Smokejumper bases at North Cascades, Cave Junction, La Grande and Redmond provided men and/or material for the project, and the Okanogan National Forest provided an information officer for the early stages of the project.

IX. INDIVIDUAL TESTS

The following individual test descriptions cover personnel, vehicles and other equipment used on each test and some of the problems and recommendations as described by the test supervisor:

MEXACARBATE (ZECTRAN)

Plot Layout
(See maps in Appendix)

Originally, it was planned for the Zectran test plots to be located on infested private timber stands. When the private landowners were informed that an unsprayed buffer strip a mile in width would be required around each study plot, they requested to withdraw their lands for use in this test. It was then decided to locate the plots on National Forest lands where spray from adjacent areas that might drift onto the study plots could be prevented.

During the week of May 20, the nine study plots were selected. A helicopter was used to locate areas with tussock moth-infested trees that still had enough foliage to support an active larval population. It was also necessary to locate these plots in accessible stands of trees of a size that could be sampled at mid-crown.

Plot size was first estimated by timing the speed of the helicopter from plot corner to corner. In some cases, the plot size was altered so the plot corners could be located in easily visible locations for the spray pilot. The helicopter landed at each prospective plot and a rapid visual check was made of overwintering egg mass numbers. Red cloth markers were then dropped from the air at each corner and the corners marked on aerial photos or half-inch scale maps.

The plot size was first computed on the photos or maps and then ground crews measured one plot side to determine the accuracy of this method. At that time, the crew also replaced the small markers dropped from the helicopter with 4 × 4 orange fluorescent cloth tacked to a light lathe frame.

Table 2.— *The number, location, size and egg mass density per thousand square inches of foliage*

Plot No.	Location T.	R.	Sec.[2]	Acres[1] in Plot	Egg Mass per 1000 sq. inches
1	2N	37E	21	247	13.5
2	2N	39E	31	600	3.6
3	2N	37E	24	293	3.3
4	2N	38E	19	593	7.8
5	1N	38E	18	400	6.4
6	2N	38E	10	393	7.2
7	5N	41E	2	420	2.8
8	2N	38E	33	478	4.4
9	2N	38E	26	446	21.0

[1]The large variation in the size of the plots was due to the selection, when possible, of plot corners visible to the spray pilot.

[2]In some cases, the plot was located in more than one section. The section containing the largest area of the plot is given.

Plots 3, 6, and 9 were used as the check plots and were not sprayed. To protect research studies then underway, it was decided to locate these plots in the same location as the Pacific Northwest Forest and Range Experiment Station's tussock moth population study plots.

Due to the possibility of Zectran sprayed on private lands drifting onto and contaminating carbaryl test plots, two plots previously selected for carbaryl testing were switched to the Zectran test.

Plots 1, 4, and 8 received one application each of Zectran; plots 2, 5, and 7 each received two applications; while plots 3, 6 and 9 were reserved as check or control plots. Locations of these plots are given in Table 2.

Egg Hatch

Test plans called for the first application on the double application plots (2, 5 and 7) to be made 3 days after 60 percent of 40 egg masses tagged on the plot had started to hatch. The second application was scheduled for 10 to 14 days later, depending on the weather and the availability of helicopters. The spraying of the single application plots (1, 4, and 8) was scheduled to occur when 90% of the egg masses began to hatch. However, an attempt was made to combine the postspray sample for the double application plots with the prespray sample of the single application plots. In some cases this prevented spraying at exactly 90 percent egg hatch (Table 3).

Plot No. 5 had a 75 percent egg hatch on June 8; the first day the egg hatch was checked. This plot was sprayed 3 days later on June 11; the second application was made 12 days later on June 23.

Plot No. 2 also had a 75 percent egg hatch on June 8; this plot was not sprayed until June 12 as the helicopter was used to spray Plot No. 5 on the 11th, which would have been the scheduled spray date. An egg hatch check on June 11 showed the egg hatch had reached 87 percent. The second application was made 12 days later on June 24.

Plot No. 7 was timed by the egg hatch on plot No. 27, a carbaryl check plot at the same elevation, located 2 miles to the east. The egg hatch had reached 73 percent on June 7 but a delay due to a spray system pump breakdown and rain delayed the first application on this plot until June 16. Egg hatch had reached 90-100 percent. The second application was made 12 days later on June 28.

Plot No. 1 had 93 percent of the egg masses hatching on June 13. This plot was sprayed on June 18 and it was assumed by the test supervisor that all of the egg masses had *started* to hatch on this plot by that date.

Plot No. 4 had an 82 percent egg hatch rate on June 12 and the plot was sprayed on June 19.

Plot No. 8 had a 67 percent egg hatch rate on June 8 which was 11 days prior to spraying on June 19.

Table 3.—*Plot numbers, applications scheduled, and treatment dates (see maps in Appendix)*

Plot No.	Application Scheduled	Application dates 1st	1-only	2nd
1	1		June 18	
2	2	June 12		June 24
3	Check			
4	1		June 19	
5	2	June 11		June 23
6	Check			
7	2	June 16		June 28
8	1		June 19	
9	Check			

Formulation of Chemical

The Zectran formulation used in this test was a dilution of 1 gallon of Zectran FS-15 mixed in 9 gallons of No. 2 fuel oil with 38 grams of the dye, Rhodamine-B extra base, added for deposit assessment. The Zectran FS-15 was kept in a locked storage area at the La Grande Fire Control Center until ready for use.

Mixing of the insecticide was done in a Forest Service mixing truck which had an internal mixer and contained pumps and screens for loading and filtering. Accurate volume meters were also mounted in the pump lines. This mixing truck was not used for transportation but was parked throughout the project at the La Grande Fire Control Center.

Steps used in the mixing of the Zectran formulation were:

1. Tank truck was cleaned with fuel oil and all hoses and pumps drained.
2. Zectran FS-15 was measured into the tank.
3. Rhodamine-B extra base dye was added to the Zectran FS-15.
4. Mixer was run for 30 minutes.
5. Number 2 fuel oil was added to mixture.
6. Mixer was run for 30 minutes or longer.
7. Before loading into transport truck, mixer was run for at least 5 minutes.
8. Before loading into the helicopter, the spray mixture was recirculated back into the transport truck by use of the loading pumps.

No major problems were encountered in the mixing of the Zectran.

Insecticide Transportation

Mixed insecticide was moved from the La Grande Fire Control Center to the heliport where it was loaded into the helicopter by tank truck supplied by the spraying contractor, Evergreen Helicopters, Inc. This tank truck was provided by a subcontractor, McCall Oil Company of Portland. Mike Fisher of McCall Oil Company served as driver and loader.

No problems were encountered in the transportation or loading of the insecticide.

Spray Application

Zectran test plots were sprayed with a Hiller 12E helicopter under contract from Evergreen Helicopters, Inc. The pilot of the spray craft was very cooperative and in the opinion of the test supervisor, did an excellent job of applying the insecticide. While the helicopter functioned properly, it was out of service for 2 days when the spray system pump went out.

The helicopter was calibrated to apply 1 gallon of the mixed insecticide per acre at 50 miles per hour on a 100-foot swath using 22 nozzles. Nozzles contained size No. 8003 tips. Nozzles were rotated forward and down at a 45-degree angle on a 30-foot boom. At 60 p.s.i. pump pressure this provided a droplet size of 150 to 170 vmd.

Application was made at approximately 50 feet above the tree tops. Spraying was prohibited or stopped when any of the following conditions prevailed:

1. Wind velocity exceeded 6 m.p.h.
2. Temperature exceeded 70°F.
3. Snow, water, or ice covered the foliage.
4. Rain was predicted to fall within 6 hours.
5. Fog covered any of the operating areas.
6. Air turbulence was great enough to affect the spray pattern.

On June 16, the morning the first application was made to plot No. 7, a heavy rainfall occurred on the plot shortly after spraying was completed. This rain prevented the accurate assessment of deposit on the cards and plates. However, it is of particular interest to note that this application provided a greater percentage of larval mortality than any other single application of Zectran. Winds in excess of 6 miles per hour delayed the application on plot No. 1 on June 18, but all spraying was completed during calm periods.

Spray plots were of a size that spraying could be completed during a single morning before the temperature approached 70°F or air turbulence developed. In fact, plots no. 4 and no. 8 were both sprayed in one morning from the same heliport in less than 4 hours. The only problem, other than rain, associated with the application of the spray to the Zectran test plots was with the helicopters' spray equipment.

A Hiller 12E, under contract from Evergreen Helicopters, Inc., was used for spray pilot orientation flights over the spray areas and to monitor the actual spraying of the area.

Ernest Collard, Forester on the Timber Management Staff, Wallowa-Whitman National Forest, served as the observer. He became familiar with the test plots and any safety hazards that might be present in advance of treatment. The afternoon prior to spraying a plot, he made a flight with the spray pilot to point out any hazards and to familiarize the pilot with the plot boundaries.

During spraying, the observer in the observation helicopter hovered above the spraying craft to be sure that spraying was properly done. The spray pilot was kept informed via radio or between loads of any changes in plans or any adjustments needed in his application methods.

This observation system worked very well. On a large-scale spray project, one observer should be able to handle two or three spraying helicopters at a time.

Population Sampling

Test plans called for five sampling periods on each plot. Counts were to be made 24 hours prior to each spray application and 96 hours after each application. Fifty trees on each plot were to be sampled and these trees were selected in clusters of ten. During each of the prespray counts, 4 branches, 15 inches long were to be cut from the mid-crown and larvae counted. When postspray counts were made, 8 branches were to be cut and counted. Because of the need to reduce costs and personnel problems, representatives from R-6 Pest Control and the Insecticide Evaluation Project agreed to reduce the number of ten tree clusters on each plot from five to four.

The ADP forms provided by the Insecticide Evaluation Project to record the data were difficult for inexperienced crews to understand. These forms were developed for card punch operators and were not practical as a field form. A new form was developed for field crews and each night the clerks on duty transferred this data to the ADP forms.

Aluminum pole pruners, with an attached basket for catching the branch after it was clipped, were provided to each 4-man crew. Usually one crew member clipped the branches, two members measured foliage area and counted larvae while the other crew member recorded the data. The poles were in sections that could be extended to 24 feet, but where possible, trees were selected so that the mid-crown could be reached with a 16-foot pole.

This sampling procedure worked quite well once the personnel were adequately trained. The data gathered by these crews are the heart of the field tests and this should be realized when personnel are recruited. This job requires intelligent and dependable people with the ability to work with minimum supervision.

Many of the personnel assigned to the sampling crews were inexperienced workers of a poor quality. Turnover was rapid and the project was half completed before students starting their summer vacations were found to properly staff these positions. In the future only qualified personnel who are capable of working without constant supervision should be assigned to this type test.

Safety

There were no aircraft, vehicle, or personnel accidents reported during the Zectran field test. It is recommended that safety clothing to be worn by the contractors' personnel handling pesticides be listed in the contract specifications. This applies to the applicator contract as well as the insecticide contract. No safe clothing or glasses were available for the personnel loading the helicopters. These had to be provided by the Forest Service.

Personnel

Personnel assigned to the test of Zectran on the Douglas-fir tussock moth and their main duties were:

David McComb, Entomologist, assigned as test supervisor.

Jack Sater, Forestry Technician, assigned as assistant test supervisor in charge of extended Zectran test.

Ernie Collard, Forester, assigned as assistant test supervisor in charge of the Zectran test plots.

Diane Zeihen, a forestry student, was used in the field to keep track of insecticide movements, helicopter flight time, weather reports and to serve as a heliport manager.

Carol Preisig and Russ Christensen served as weathermen each morning during the spraying period. Upon completion of the spraying, they then checked the volume of spray deposited on the study plots.

Ron McMinimy, a smokejumper assigned from Cave Junction, served as leader of the crew sampling tussock moth populations in the Zectran test plots.

Ismael Caballero, a forestry student from Washington State University, served as crew leader when Ron McMinimy returned to smokejumping duties on June 28.

Leo Wilhelm was promoted from the sampling crew to replace Caballero for the final larval and egg mass sampling counts.

Orin Corrack and Pete Sawin served as egg hatch checkers early in the project. Later both served as weathermen and Pete became a heliport manager.

Scott Billings, a forester, served as a weatherman and as the heliport manager.

Many individuals served during one period or another on the population sampling crew. Due to ceilings on Forest Service personnel, many of the employees hired temporarily for the test were on the Oregon State Forestry Department payroll. Many State personnel assigned to the sampling crews were high school dropouts and some were only 16 and 17 years old. In general, most of these employees were of an inferior type for use on a job where close supervision is difficult. When the work became difficult or the weather bad, there was a rapid turnover in personnel which resulted in a need for continual training.

Individuals used at some period of time on the crews sampling tussock moth populations on the Zectran test plots were:

Dennis Lassley	Darrell Lowe	John Stewart
Steve Van Rossum	Ruth Odegaard	Mary Ann Frye
Denny Huddleston	Russ Christensen	Robert Griffin
Linda Bafford	Kathy Wyatt	Tony Webster
Leo Wilhelm	Carol Preisig	Philip Myer
David Sherburn	Paula Feik	
Dennis Thompson	Lori Tuttle	

Test supervisors and assistants were on call at all hours and most days were on duty from 3:00 a.m. until 8:00 p.m. with a 2- or 3-hour break in mid-day.

Equipment

Supplied by Oregon State Forestry Department:

1. Office space in three buildings at La Grande
2. Vehicle parking space
3. Some telephone service

Supplied by Evergreen Helicopters:

1. Helicopter and pilot for applying Zectran
2. Helicopter and pilot for observation flights
3. Fuel and equipment pickup
4. Tank truck for hauling mixed Zectran

U.S. Forest Service, Missoula Equipment Development Center:

1. Tank truck for mixing Zectran and dye

U.S. Forest Service, R-6:

1. Vehicles
2. Hand tools
3. Telephone services
4. Data forms
5. Plot marking material

U.S. Forest Service, Wallowa-Whitman N.F.:

1. Vehicles
2. Aerial photos
3. Radio facilities and equipment

U.S. Forest Service, Umatilla N.F.:

1. Vehicles
2. Aerial photos
3. Radio facilities and equipment

TRICHLORFON (DYLOX)

Plot Layout
(See maps in Appendix)

An attempt was made to locate all plots on National Forest lands, but due to the difficulty in locating plots that met the necessary criteria, several plots were selected on private land with the landowners permission.

A helicopter was used to help locate potential plot sites and these areas were then ground checked for suitability. Because other tests were located throughout the infestation areas, the Meacham area was selected for the trichlorfon plots. This area was more lightly infested than some of the other areas and it was difficult to select plots with a heavy enough infestation to meet the minimum criteria for number of egg masses per 1000 square inches of foliage.

Plot size was computed on aerial photos and maps and then measured on the ground to check accuracy. Plot locations were marked with fluorescent cloth at each corner for spraying accuracy.

Egg Hatch

Egg hatch was first observed on plot No. 13 on May 24. Spraying started on the first block 4 days after 60% of the egg masses had started to hatch. Egg hatch in all plots was about the same, and spraying could have stayed on schedule. However, because of the weather, plots were sprayed when weather permitted rather than when sufficient egg hatch had taken place. This resulted in most applications being applied later in the development period than planned. For data on spray plots, sampling and spraying schedule see Table 4.

Formulation of Chemical

Mixing took place at the La Grande Airport and the material was transported to the heliport in the tank truck. Three batches were mixed as follows:

Date	Batch Size	Dylox[1]	Oil[2]	Dye[3]
June 7	1,800 gal.	1,200 gal.	555 gal.	45 gal.
June 15	525 gal.	350 gal.	160 gal.	15 gal.
June 19	225 gal.	150 gal.	70 gal.	5 gal.
	2,550 gal.	1,700 gal.	785 gal.	65 gal.

[1]From Chemagro: Dylox 1.5. Mixing ratio: 2 parts of Dylox 1.5 oil with 1 part crop spray oil. This equals one pound of actual Dylox applied per acre in a total volume of one gallon per acre.

[2]From Sun Oil Company: Sun Spray 7N and Orchex 796 crop spray oil, both with the same specifications.

[3]From PNW-2208: Rhodamine-B Extra dye. One quart per 10 gallons of final formulation. Dye volume replaced crop spray oil.

The Dylox 1.5 in the 50 gallon drums was stirred and then recirculated in the drum so that the material was uniform. This was necessary as the heavier particles settled to the bottom during transport and storage.

Table 4.—*Data on spray blocks, sampling and spraying schedule for Dylox (see maps in Appendix)*

Block No.	Application	Plot Size	Total Gals. Sprayed	Damage Class[1]	Sampling and Spraying Schedule
17	Double	361	330	III	Pre 6/9, spray 6/10, post 6/15, pre 6/21, spray 6/24, post 6/28
14	Double	151	140	II	Pre 6/10, spray 6/11, post 6/16, pre 6/24, spray 6/24, post 6/29
11	Double	292	250	II, III	Pre 6/11, spray 6/12, post 6/18, pre 6/24, spray 6/25, post 6/29
13	Single	396	390	II, III	Pre 6/9, 6/18, spray 6/20, post 6/25, 6/30
16	Single	260	260	III	Pre 6/10, 6/16, spray 6/20, post 6/25, 6/30
10	Single	237	240	III	Pre 6/11, 6/22, spray 6/24, post 6/28, 7/1
12	Control	-	-	II	Pre 6/9, pre 6/15, post 6/25, post 6/28
15	Control	-	-	II	Pre 6/10, pre 6/16, post 6/26, post 6/29
18	Control	-	-	II	Pre 6/11, pre 6/19, post 6/26, post 6/30
Total		1,697	1,610		Pre = prespray sample Post = postspray sample

Plot boundary corners were marked with large plastic red sheets. An "L" shape was laid out on all corners showing interior of plot and direction (legs of "L") of other three corners.

I - Fifty percent or more of the host type has been completely defoliated.
II - Fifty percent or more of the host type has at least the top quarter of the crown completely defoliated.
III - Host type has defoliation visible from survey aircraft. The current years foliage has been removed on most trees but less than a quarter of the crown has been completely defoliated.

Chemicals were pumped from the respective containers into the tank truck using the pump system on the truck. Each batch was stored in the tank truck and in the case of the first batch, for a period of 7 days.

The tank truck had been previously used on a herbicide project where water for mixing was pumped from streams and ponds. The entire system had sand, water, and other debris in it. Many hours were spent cleaning the system. The mixed material was agitated for 30 minutes before being pumped through a 50 mesh screen and into the helicopter holding tanks. This screen was checked and cleaned periodically.

Spray Application

The Dylox was applied by a Bell 47G helicopter under contract from Mountain Air Helicopters in Salem, Oregon.

Final calibration of the helicopter differed somewhat from that in the study plan. Thirty-two instead of 22 nozzles were used because boom pressure was below the required 60 psi. Pressure was around 55 to 58 psi and in one case dropped down to 45 psi. New no. 8003 teejet nozzle tips with slotted screens (size 32-7 slots) were used. Air speed was about 50 mph with a swath width of 60 ft. A 40 mesh in-line screen was used and had to be cleaned frequently; sometimes after every load. Flow rate as determined by bagging every other nozzle and at 58 psi was 36 ounces per nozzle per minute.

Many of the nozzles plugged, particularly towards the end of the boom, and had to be cleaned or replaced after every load. This problem contributed to the drooling and accounted for some of the large spray drops.

The boot connecting the twin tanks on the helicopter leaked often. It completely came apart enroute to a spray block and most of one load was lost. The connecting arm around the boot had to be completely refiberglassed.

The radio in the spray helicopter only worked intermittently, making it difficult to communicate with the observation helicopter. Radio communication between the ground and observation helicopter was good at all times.

The electrical wires on the engine of the tank truck burned out towards the end of the project. The chemical could not be pumped into the helicopter tanks until the system was repaired.

The Meacham area seemed to be blessed with wind. If it was not raining, hailing, or snowing, the wind was blowing beyond the standard. These problems delayed the spraying schedule for as much as a week in some cases.

Population Sampling

Population sampling was done in the same way it was done on the Zectran-treated plots.

Safety

There were no accidents during the entire project. One driver was replaced because of poor driving habits.

Personnel

Name	*Position*	*Hours Worked*
LeRoy Kline	Test Supervisor (For. III)	396
Paul Joseph	Evaluation Leader (Lab. II)	335
Gene Irwin	Evaluation Leader (Tech. II)	376
Gus Hill	Aerial Observer (Tech. II)	150
Phil Hufstader	Heliport Mgr. (Tech. I)	161
Mark Schwebke	Spray Deposit & Weather (Lab. I)	364
Darryl Lowe	Spray Deposit & Weather (Lab. I)	120
Gregg Nelson	Evaluation (Lab. I)	153
Keith Baker	Evaluation (Lab. I)	90
Dan Cork	Evaluation (Lab. I)	95
Dennis Cork	Evaluation (Lab. I)	246
Kathy Wyatt	Evaluation (Lab. I)	131
Phil Morris	Evaluation (Lab. I)	94
Dan Morris	Evaluation (Lab. I)	230
Mark Bachand	Evaluation (Lab. I)	70
Ruth Odegaard	Evaluation (Lab. I)	96
Jim Craddock	Evaluation (Lab. I)	160
Terry Van Leuven	Evaluation (Lab. I)	170
Lynn Bethel	Evaluation (Lab. I)	265
Gene Smith	Evaluation (Lab. I)	224
Wendy Banchard	Evaluation (Lab. I)	60
Connie Garner & Crew	Chemagro Advisors	250
Total - 22		4,236

Equipment

Number and Type	*Miles*
65-405 Pickup	2,103
65-129 Pickup	2,013
64-108 Pickup	7,808
72-109 Pickup	544
64-115 Pickup	2,300
72-006 Station Wagon	4,458
Chevy II, Sedan	4,706
Total 7	23,932

CARBARYL (SEVIN 4-OIL) TEST

Plot Layout
(See maps in Appendix)

Plots were marked at the four corners with strips of fluorescent cloth. Very few of these survived the life of the plot; some disappeared, while others were torn up and scattered. It would seem that flagging hung from trees would stay in place longer than the ground markers did.

Plot No. 26 has been cut over. Sample trees were selected from second growth reproduction, some of which were overtopped by larger trees. Plot No. 27 sample trees were tightly grouped together, so that they probably did not represent the average of the plot. Plot No. 28 had good distribution of sample trees. The population which occurred on the mature overstory trees was not sampled, but sample trees were seldom mixed with overstory trees.

Plot No. 29 — Good sample trees were difficult to find, since the area was cut over within the last 10 years.

Egg Hatch

On plots 25 and 27, the egg masses selected for checking egg hatch were not representative of the entire plot. Additional random sampling was necessary to determine actual egg hatch at a given time. Again this is probably a function of the plot location.

Plot No. 25 had very slow egg mass development. Invading larvae did a significant amount of defoliation before the egg hatch occurred on the plot. There was also a significant difference in the date of hatching within the plot.

Plot No. 30 — Hatch occurred several days earlier than No. 25 and, therefore, had much heavier defoliation when sampled.

Formulation of Chemical

The insecticide used on plots 25, 26 and 27 was carbaryl (Sevin). It was prepared by mixing diesel at the rate of 1 gallon of Sevin 4-Oil (from 55 gallon drums delivered to La Grande) with 3 gallons of diesel (purchased at La Grande). This formulation was applied by helicopter at the rate of 1 gallon per acre. One quart of dye (Rhodamine-B) was added to each 10 gallons of mixed spray. A typical batch was prepared by drafting out 55 gallons of Sevin 4-Oil (one drum into the mixing tank). Oil was then transferred to the mixing tank from the storage tank; 5.5 gallons of dye were added using a half gallon measure. The spray tank was finally filled to the 220 gallon mark. Calibration of the tank was, however, insufficient to determine exact gallonage.

All mixing was done in the field at the heliport chosen for each spray plot. One Forest Service man (either Scott Billings or Eric Schoenfield) was assigned to mixing. Mixing was done by Forest Service employees with help from Union Carbide representatives. The test supervisor was personally present when most of the mixing was done.

Spray Application

Application was accomplished with a Bell G3 B1 under contract to Helicopter Services, Inc. from Yakima, Washington. The pilot who sprayed plots 26 and 27 was experienced and did a good job of spraying. Because of the length of time between spraying plot No. 26 and plot No. 25, 13 days, the first pilot had to return to his place of employment and another pilot was substituted. This may have caused some lack of comparability in spraying of the three plots.

In mixing the chemical for plot No. 27, the hose between the pump and tank broke. Fortunately, it occurred just before filling the last load and there was little pressure from the material inside the spray tank. The crew managed to wrap the hose and use gravity to drain the tank and fill the helicopter with the last of the mix. A shut-off valve between the tank and the hose would have reduced this problem.

On plot No. 27, the first plot sprayed, there was some loss of pressure in the helicopter spray system. It was found that the in-line strainer was fouled with a thickened material, as if water had been emulsified in the spray. The screen was cleaned and no more trouble developed.

A light intermittent rain fell during the last period of spraying plot No. 27. This continued after completion of the spraying. The dye was washed from some of the aluminum plates and the Kromekote cards were wet. This may have had some effect on the spray deposit data.

Spraying of plot No. 26 went well except that a few large drops were found on a pickup which had been parked in the spray area. However, a study of spray cards in the area didn't indicate that large droplets were a problem. It was found that one nozzle sprayed against the rearview mirrors and caused a drool. This was corrected immediately.

No problems were indicated in the spraying of plot No. 25, but a leak developed in the hose used in loading insecticide in the helicopter. All loading after this had to be done by gravity. A replacement hose on hand would have avoided this problem.

Population Sampling

Pre- and postcontrol sampling data are the best indication of levels in each plot, but considerable population variation occurs within trees, between trees, and therefore within the plot.

Plots varied considerably in the population level at different parts of the plot. Those on side hills seemed to have the greatest variation, usually with the higher population at the higher elevation.

Following is a table showing plot numbers, acres sprayed, egg mass densities per 1000 sq. inches of foliage, sampling dates and spray dates:

Table 5.—*Egg Mass Density and Sampling Dates for Carbaryl Test Plots*

Plot No.	Actual Acres	Estimated Sprayed Acres	Egg Mass Density per 1000 sq. in.	Date Prespray Sample	Date Sprayed	Date Postspray Sample	Second Postspray Sample	Pre-pupal Sample
25	277	300	5.8	6/21	6/23	6/27	7/7	7/30
26	456	500	4.2	6/9	6/10	6/14	6/24	7/27
27	278	300	0.6	6/8	6/9	6/13	6/23	7/24
28	428	Check	2.2	6/8	--	6/13	6/23	7/25
29	598	Check	1.3	6/9	--	6/14	6/24	7/23
30	355	Check	3.9	6/21	--	6/27	7/7	7/31

Safety

No accidents occurred on this test with the exception of one involving a leak in the hose used to load the helicopter with spray mixture. This leak caused the test supervisor and the loader for the spray contractor to get partially covered with spray. Quick action in washing affected parts with soap and water and changing clothes prevented any ill effects from the spray mixture.

Personnel[5]

Name	*Position*
Galen Trostle	Test Supervisor
Scott Billings	Weather Observer and Egg Hatch Checker
Norman Dunlap	Weather Observer and Egg Hatch Checker
Wayne Hyde	Assistant Test Supervisor
Eric Schoenfield	Weather Observer and Egg Hatch Checker
Larry Hyde	Crew Leader
Ray Farinetti	Crew Leader
Darrell Kohse	Crew Leader (State of Washington)
Mary Ann Frye	Spray Deposit Checker
John Stewart	Spray Deposit Checker
Dennis Thompson	Spray Deposit Checker
Jim Craddock	Sampling Crew (State of Oregon)
Lynn Bethel	Sampling Crew (State of Oregon)
Eugene Smith	Sampling Crew (State of Oregon)
John Brading	Sampling Crew (State of Washington)
Tony Webster	Sampling Crew (State of Washington)
Russell Fick	Sampling Crew (State of Washington)
Phillip Meyer	Sampling Crew (State of Washington)
Richard Little	Sampling Crew (Assigned to Oregon State Crew)
Robert Anderson	Sampling Crew (Assigned to Oregon State Crew)
David Sherburn	Sampling Crew (Assigned to Oregon State Crew)
Darryl Shimznek	Sampling Crew (Assigned to Oregon State Crew)
Linda Spence	Sampling Crew (Assigned to Oregon State Crew)
Ruth Odegaard	Prepupal Sampling Crew
Kathryn Wyatt	Prepupal Sampling Crew
Leo Wilhelm	Prepupal Sampling Crew
Paula Fick	Prepupal Sampling Crew
Darrell Lowe	Prepupal Sampling Crew
Russell Christensen	Prepupal Sampling Crew
Lori Tuttle	Prepupal Sampling Crew
Tony Webster	Prepupal Sampling Crew
Eldon Best	(filled in for absent crew members)

A total of 32 personnel were assigned to this project at one time or another, to maintain the 16 positions on the test. Much transferring of people occurred with the State of Oregon and the Zectran test personnel in order to make the best use of the people available. Smokejumpers were used as crew foreman commencing about the middle of May, but most of them had to return to their home bases for training on June 9. New crews were hired in July to make the prepupal sample since most crews were laid off at the end of the last postspray sample in June.

This constant changing of personnel caused some severe training problems.

[5]Some personnel on this list were also used on the Zectran test.

Equipment

Equipment was transferred liberally between the carbaryl test and the Zectran test. Equipment used during the project was as follows:

Type	*Number*
Station Wagon	7475
Station Wagon	42564
Pickup	UM-21
Pickup	UM-23
Pickup	UM-24
Pickup	UM-26
Pickup	UM-28
Pickup	UM-29
6-passenger pickup	153943
Sedan Delivery	37896
Personal Car	(Test Supervisor)
4 × 4 Carryall	7162

Mileage for these vehicles averaged about 150 miles per day. Because most of the sampling crews consisted of four people and due to the shortage of crew type vehicles, it was necessary to use two pickups for some crews.

BIOETHANOMETHRIN (BEM) FIELD STUDY

Plot Layout
(See maps in Appendix)

All BEM test plots were located in Washington. A minimum spacing of 1 mile between spray plots and the unsprayed control areas was required to prevent spray contamination. This required large tracts of tussock moth-infested areas with road access, which were in short supply in this area.

The Pomeroy Ranger District, Umatilla National Forest, in southeastern Washington was selected because it supported large areas of Class II and III tussock moth defoliation. The Walla Walla District which contains the Walla Walla watershed was not considered because of limited access to the defoliated stands and conflict with the active timber salvage sales.

The Pomeroy District boundary lies about 12 miles south of Pomeroy, Washington. This district contains the Wenaha back country area that supports the bulk of the tussock moth defoliation. All motorized vehicles are excluded from this area. Many areas with road access were inaccessible during May and June because of snow drifts. Two main ridges running north and south comprise the main portion of this district. These two ridges are separated by the Tucannon River drainage. The eastern ridge, T. 9 N., R. 42 E., was accessible in May as far south as the Clearwater Lookout. Road N911 south of this point was closed by snowdrifts. The road on the western ridge, T. 8 N., R. 40 E., located about 10 miles southeast of Dayton, Washington, was clear as far south as the Godman Lookout but the tussock moth damaged timber stands were generally located along the ridge face or in drainages that were not approachable by roads or trails. Because of the steep terrain that separated these two ridges, there was no east-west access on the district. To travel from one ridge to the other, it was necessary to drive northward almost to Pomeroy to find a driveable road connecting Road N98 along the Tucannon River with Road N911 on the eastern ridge.

A helicopter, Bell 47G3B-2, was available during mid-May and it was used to scout the Pomeroy District to become acquainted with the district and to map potential test sites. Plot selection criteria included vehicle access for the sampling crews, detectable defoliation, and sufficient egg mass density to insure relatively high tussock moth population level. About 4 hours of helicopter flying time was used to inspect the northern half of the district and locate potential test plot sites that would be visited on the ground.

Three plots were located on the eastern ridge and were scheduled for egg mass density evaluation. These areas were Rose Springs, Abel Ridge, and Huckleberry Butte. Two potential plots met the criteria along the western ridge, San Souci and Lewis Creek, and two were located at the base of this ridge along Little Tucannon Creek and Panjab Creek. Both of these creeks were active and flowed into the Tucannon River.

Tussock moth egg mass density determinations were made at each potential test area. Twenty-five host trees with visible defoliation were selected within each area, two branches were cut from the mid-crown, on opposite sides of the tree stem, branch foliage area was measured and a tally made of all old and new egg masses found on each branch. To qualify for acceptance, each area had to support one new egg mass per thousand square inches of foliage. The average new egg mass densities per 1000 sq. inches of foliage are listed below:

Table 6.—*Average Egg Mass Densities per 1000 sq. in. of Foliage*

No.	Area	Average Egg Density	Location
19	Rose Springs	4.6	9N, 42E, S4
22	Abel Ridge	1.9	9N, 42E, S8
20	San Souci	4.4	9N, 40E, S12
23	Little Tucannon	3.4	9N, 40E, S25
21	Lewis Creek	5.6	9N, 40E, S16
24	Panjab Creek	3.0	9N, 41E, S7
	Huckleberry Butte	0.9	9N, 42E, S19

The Huckleberry Butte area was rejected because the average egg mass density was below the minimum of one egg mass per thousand square inches of foliage.

Treatment assignment by plots was to be randomly decided. This did not occur on the Pomeroy Unit because both the Little Tucannon and Panjab were active and water from the Tucannon River was used by a State fish hatchery located about 5 miles downstream from these plots. Because BEM is toxic to brook trout, a request was made by the District Ranger not to treat either the Little Tucannon or Panjab Creek blocks. The same decision was made for Lewis Creek by the District Ranger until an investigation revealed that this creek was dry and presented no contamination source for the Touchet River. The District Ranger felt that the Abel Ridge block should also remain untreated because of the active cattle grazing allotment within and adjacent to this site. Spraying approval was therefore confined to Rose Springs, San Souci, and Lewis Creek blocks. The paired untreated plot for each of these units was Abel Ridge, Little Tucannon, and Panjab Creek.

Only the spray plot boundaries were located on the ground, marked, and areas computed. No area computation was made on the check plots. Fortunately, the Pomeroy District is well surveyed and marked. Section line signs were posted along the more frequently used roads. Project crews had no trouble locating themselves on aerial photos and district maps. Plot corners were mapped and areas computed. Areas in the treatment plots were as follows:

Plot No.	*Block*	*Acres*
19	Rose Springs	464
20	San Souci	550
21	Lewis Creek	535

The number of acres determined the total amount of insecticide that would be applied at the rate of 1 gallon per acre.

The Rose Springs plot boundary locations caused some problems. The initial objective was to spray all of Section 4 and extend the southern boundary to include the permittee dwellings at Rose Springs (Section 9). Trees around these homes were defoliated and supported large numbers of new egg masses. Because all of these permittees could not be located in time to sign a spray release form, Rose

Springs (Section 9) was not included in the spray plot. The final spray boundaries were Road N911 on the west, the Forest boundary on the north, section line between Sections 4 and 3 along the east side and the south section line between 4 and 9. The northeast quarter of Section 4 contained private land and a decision was made to include these areas if the owners agreed. These landowners were eager to have their trees sprayed to prevent further damage. They were informed that the insecticide effectiveness was not proven and the diluent, Pansol AN3, could cause paint damage. All the owners, E. J. Baker, C. E. Cassell, and N. D. Zander, signed a release form. Mr. Baker's property contained a pond in the extreme northeast corner of Section 4 that had recently been stocked with trout fingerlings. He requested that this 40-acre block remain untreated. This area was marked and the spray contractor was shown the boundaries of this site from the air and instructed to keep spray drift away from the pond.

Egg Hatch

Soon after the spray plots were located and defined, 40 egg masses were located, tagged, and inspected regularly to determine when hatch began to occur and when 90 percent or 36 egg masses had begun to hatch. Spraying was to occur when the 90 percent level was reached.

Plot	*Elevation*	*Date*	*Total Hatched No. of Egg masses*	*Percent Hatched*
19	4500	June 4	2	5%
		6	12	30%
		8	39	98%
20	5300	June 8	1	3%
		11	8	20%
		13	16	40%
		19	21	53%
		21	39	98%
21	5000	June 5	5	13%
		7	7	18%
		10	26	65%
		13	37	93%
		19	40	100%

Egg masses on the lower elevation plots, Little Tucannon and Panjab Creek reached 100 percent hatch by June 8.

Formulation of Chemical

Bioethanomethrin (*d-trans* enthano chrysanthemate of (5-benzyl-3-furyl alcohol), RU11679-ENT No. 27985B, is a synthetically produced pyrethroid that exhibits about the same characteristics as the botanical insecticide pyrethrum that is extracted from chrysanthemums. BEM is a broad-spectrum insecticide that exhibits low persistence and is about 215 times more toxic to Douglas-fir tussock moth than Zectran. Toxicity can be classed as moderately dangerous based on rat and mice LD_{50}'s which range from 84 to 145 mg/kilogram, and bird LD_{50}'s which range from 117 to 165 mg/kilograms for female quail or 200 to 1600 mg/kilogram for female mallards. Fish exhibit acute sensitivity to BEM. One hundred percent brook trout mortality will occur after 3 hours when exposed to 10 ppm and the same mortality level will be reached in 24 hours when exposed to 0.01 ppm.

Diluent.—The diluent used in this field study was Panasol AN3 which also exhibits some biological activity. The LD_{50} for rats is 4000 mg/kilogram plus. The solvent was reported to rapidly deteriorate rubber. The Aerial Application Project (No. 2208) at Corvallis, Oregon, conducted airport tests to determine what spray drop spectrum would give optimum tree coverage using BEM and Panasol. After these tests were completed, they verbally reported that new rubber diaphragms in the helicopter spray nozzles lost their elasticity and stretched. No follow-up detail examination was made to determine further affects on rubber hoses connecting the spray tanks, pump, and booms. They also observed that spray spots on automobile paint surfaces lifted the paint. General Motors painted surfaces seemed to be more susceptible to spray damage than other car manufacturers. We were advised that all vehicles within the sprayed plots should be removed or covered to prevent paint damage. The helicopter contractor doing the spraying could also expect paint damage and rubber deterioration.

Formulation.—The spray formulation used in this field test was 0.01 pounds of BEM in one gallon of Panasol with 37 grams of Wingstay 100 stabilizer and 3.8 grams of Rhodamine-B Extra base dye used for spray deposit evaluation. Aerial Application Project personnel from the Corvallis laboratory helped mix this formulation and twenty-nine 55 gallon (1,595 gal.) drums were shipped to La Grande, Oregon, for storage.

Spray Application

The Rose Springs block was ready for spraying on June 11 but the spray helicopter was not calibrated until June 12 and it could not maintain spray boom pressure greater than 50 psi. The helicopter spray system was repaired on June 13 and the helicopter returned to Pomeroy late that afternoon. Rain began that evening and continued throughout the night. Early weather reports on June 14 predicted a clearing trend. Because Rose Springs and Abel Ridge were prespray sampled on June 13, the decision was made to assemble the two helicopters at the Clearwater helispot located about 5 miles south of the spray block. The weatherman was instructed to set up the weather station on a ridge overlooking Rose Springs and begin recording temperatures and wind velocities. The rain stopped at 8:30 a.m. By 11:00 a.m. the tree foliage was dry and the decision was made to apply 40 gallons of spray to test the spray drift. The drainage was sheltered from the higher wind gusts recorded along the ridge and the spray pattern did not break up but settled into the tree crowns. Dr. Fred J. Preiss, Entomologist with the McLaughlin Gormley King Co., BEM supplier, viewed the spraying from the ground and from the observation helicopter. He was satisfied that the spray pattern was moving down into the tree crowns as planned. Since the Study Plan did not specifically state that all spraying would be done only between the hours of 5 to 8 a.m., the decision was made to complete spraying. The last spray load was applied at 2:30 p.m.

The observation helicopter helped the spray contractor immensely by hovering over the spray boundary so that the spray helicopter could line himself up on the correct spray line. When he began spraying and passed the halfway point, the observation helicopter would fly over him to the opposite spray boundary, line the helicopter with the spraying helicopter, move over one swath width, and hover. The spray ship would make a spray turn just beyond the block boundary and align his flight line with the hovering helicopter. The overflight at the center of the flight line provided an opportunity to check the spray discharge and determine which nozzles might be clogged. When clogging was detected, this information was radioed to the helispot and all nozzles were cleaned while the helicopter was taking on another insecticide load.

According to egg hatch, the Lewis Creek block, Plot 21, was ready for spraying on June 15. All crews and helicopters assembled at the Stockade Springs helispot at 5:30 a.m. that day. Continuous rain mixed with snow cancelled the project that day. The decision was made to shift spraying to Zectran on private lands where weather was more favorable. Climatic conditions became more stable and BEM applications resumed on June 21 when Lewis Creek, Plot 21, was sprayed. San Souci, Plot 20, was treated the following day.

Population Sampling

After the study plots were established, the field crews selected 50 trees divided into five clusters of 10 trees each. These trees were marked with red and yellow plastic ribbon and two, 5 by 8 cards were securely fastened on opposite sides of the bole about breast height. Plot and tree number was inscribed on each card.

The five tree clusters on the Rose Springs block (Plot 19) were spaced along a road that extended from east to west and bisected the block. Abel Ridge (Plot 22), the unsprayed block, contained the sample tree clusters that were spaced along a road extending northward from Section 7 into Section 8. The San Souci (Plot 20) tree clusters were located along a ridge that defined the eastern boundary. The paired unsprayed area, Plot 23, contained tree clusters between the spur road and Little Tucannon Creek. Lewis Creek (Plot 21) tree clusters were scattered along an old logging road that ran northwestward parallel to the main drainage. Tree clusters at Panjab Creek (Plot 24) extended from the confluence of Panjab and Meadow Creek northward to a campground.

The prespray sampling was done the day before the block was scheduled to be sprayed. The plan was to sample both the spray block and its paired unsprayed area the same day.

During the prespray sample, four branches were cut at mid-crown from each of the 50 tagged trees and the data recorded as outlined in the Study Plan. Four days after the spray was applied, the first post-spray sampling was scheduled. During this sampling, eight branches were cut and evaluated from each tagged tree. The second postspray samples were collected 14 days after spraying. The same collecting methods were used as for the first postspray sampling.

Plot	Prespray Sample	Sprayed	First Postspray Sample	Second Postspray Sample
		JUNE		
19	13	14	18	28
22	13	--	19	28
				July
20	21	22	26	6
23	21	--	26	5
21	20	21	25	5
24	21	--	25	6

Safety

The spray helicopter experienced some trouble when spraying. The system had a tendency to form an air lock in the boom. When this occurred, the contractor had to land the ship and bleed the spray boom by opening a valve at the end of the boom. This occurred about every other spray load and delayed application. Finally, to solve this problem, a bypass line was installed connecting the spray system with the insecticide tanks. This worked well until the last plot was sprayed. The spray ship applied one load that morning and was returning to San Souci with the second load. Before reaching the spray block, the contractor applied pressure to the spray system which caused the bypass line to rupture. About a pint of spray splashed on the supercharger, ignited, and produced a flash fire. The contractor made an immediate emergency landing and the observation helicopter landed nearby to assist. The only damage was scorched paint along the tail boom. The spraying continued but the airlock problem returned. No other accidents occurred on this project.

Personnel

Three smokejumpers were assigned to this project. They were each assigned a spray block and the paired unsprayed block. Their responsibility was to lay out the block boundaries, locate and mark the corners, establish the five tree clusters in each block, and sample these clusters. Rick Oliver was assigned Plots 19 and 22, Doug Bucklew Plots 20 and 23, and John Dorn Plots 21 and 24. Three men were assigned to each smokejumper.

Jim Simonson, Silviculturist, from the Umatilla Supervisor's Office was detailed to the project as Assistant Project Supervisor. He was responsible for the helispot operation when BEM was applied. He also supervised the Zectran operation on private lands.

The following people were involved with this test:

Umatilla National Forest

Ella Gibson — Weather and Crew Leader
Wayne Kidwel — Helispot Manager

Washington State Department of Natural Resources

Art Benefiel — Sampling Crew
Dave Chamberlin — Sampling Crew
Larry Cronin — Sampling Crew
Ed Estell — Sampling Crew
Paul Knight — Sampling Crew
Rick Saturn — Sampling Crew
Tom Seiner — Crew Leader
Jim Stonecipher — Sampling Crew
Gerrie Goddard — Sampling Crew

Later Additions:

Umatilla National Forest

Dallas Berringer — Sampling Crew
Donna Newcomb — Weather
Susan Wait — Helispot Load Recorder

Cave Junction Smokejumper

John Robinson

Both Doug Bucklew and John Dorn left the project before their plots were sprayed. Doug had to leave for Denver because of a family emergency and John returned to his smokejumper base for additional training. John Robinson joined the project after Bucklew and Dorn left. Robinson headed the crew that laid out the aluminum plates and Kromekote cards before spraying and collected them after the blocks were treated.

Equipment

Vehicles were a problem on the project. The Washington State crews were assigned two sedans that were not mechanically sound. They were not in any condition to use on the Pomeroy District's gravel roads. The State crews were not licensed to drive U.S. Government vehicles; this placed additional driving chores on the Forest Service personnel assigned to the project. Travel time was greater because there were no east-west roads connecting the two ridges where the spray blocks were located.

X. RESULTS

Results of the tests were highly variable and somewhat inconclusive. The whole tree visual classifications were especially troublesome when evaluating differences in tree conditions. The technique used was too subjective for effective evaluation of tree condition with consistency and reliability (Table 9 of Appendix). The problem is acute in the Zectran and carbaryl tests where there was considerable turnover in crew personnel. The problem is not apparent in other test data.

The following is a brief summary of results for each chemical tested (Reference Tables 9-12 in the Appendix).

MEXACARBATE

The single application averaged 52% larval mortality for the three plots, with a high of 90% and a low of 11%. The double application averaged 82% for the three plots with a high of 93% and a low of 76%. The spray deposition from cards and plates for the single application ranged from 6% to 19% and averaged 10.9% and for the double application, ranged from 15% to 22% and averaged 18.6%. An estimate of deposition from foliage samples indicated an average of 21.7% for the single application and 28.3% for the double application plots (Tables 8 and 9 of Appendix).

However, despite the relatively high larval mortality and relatively good spray deposition, the amount of foliage saved, especially in the new growth, was unsatisfactory. Overall tree condition deteriorated only slightly less than on the control plots for both the single and double applications. Further testing will be necessary before this material can be considered for possible registration.

TRICHLORFON

The single application averaged 74% larval mortality for the three plots with a high of 93% and a low of 39%. The double application averaged 90% with a high of 98% and a low of 81%. The spray deposition for the single application based on cards and plates was very good, ranging from 24% to 31%. The spray deposition for the double application was more variable, ranging from 12% to 44%, but was still very good. An estimate of spray deposition from foliage samples for the single application was 37.9% and for the double application averaged 38.3%.

Again, as in the case of Zectran, the larval mortality was very good and the spray deposit was good, but the foliage saved was not satisfactory. Overall tree condition at the time of the postspray sampling was no better than that on the control plots for the single application and only slightly better than the control plots for the double application. Further testing should be done before this material is considered for registration (see Table 9 of Appendix).

CARBARYL

Because of its longer persistence, carbaryl was tested only at the single application rate. Larval mortality averaged 83%, ranging from a high of 90% to a low of 79%. Spray deposition based on cards and plates was rather poor, ranging from 5% to 16%; however, based on foliage samples, deposition averaged 15.6%. This may indicate poor card placement. Again, as in the case of Zectran and trichlorfon, the foliage saved was unsatisfactory. Overall tree condition at the time of the postspray sampling was only slightly better than that on the control plots.

Carbaryl, despite the fact that deposition was apparently somewhat low, caused a relatively high larval mortality. With further testing, carbaryl should be a good candidate for registration (see Table 9 of Appendix).

BIOETHANOMETHRIN

This synthetic pyrethroid was tested only at the single application rate, primarily because enough material was not available to make a double application. The material that was used in the test was flown over from France and no more was available for testing at the time.

The larval mortality averaged 44%, with a high of 83% and on the plot with lowest mortality, the population actually increased from the prespray sample to the postspray sample; this despite the fact that spray deposition was higher on this plot than on the other 2 plots. Spray deposition based on cards and plates was poor on all three plots ranging from 6% to 10%. However, based on foliage deposition, the average was a high 42.3%. Again, this may indicate poor card placement. The amount of foliage saved was unsatisfactory. Overall tree condition was only slightly better at the time of the postspray sample than on the control plots.

This chemical had the poorest results of any of the four candidates tested, even though the foliage deposit data indicates relatively good spray deposition. It is possible that .01 lbs./acre is not enough active ingredient for this insect. It needs further testing before being considered for registration.

EXTENDED ZECTRAN TEST

Because of the higher priority given to the individual plot test, it was not possible to establish many effectiveness determination plots on the extended Zectran test areas. However, data was obtained from 13 plots for insect mortality and five plots for defoliation damage. No spray deposit assessments were made on the extended Zectran test area.

Insect mortality averaged 80% on this area with a high of 98% and a low of 7%. However, despite the relatively good insect mortality, foliage saved was unsatisfactory since there were no real differences in foliage condition before or after spraying (see Table 12 in Appendix).

XI. RECOMMENDATIONS

During the course of the project, some problems arose that could be avoided in future projects. If planning for future projects takes into account mistakes from previous projects, each successive aerial spray project can be done more efficiently. Some recommendations, based on the experience on this project, are as follows:

1. Contracting for helicopters should be done as early as possible. Usually by April most helicopters are committed to other projects and the few that may be available after April 1 tend to increase their bid prices.

2. Contracts should be checked and double checked before advertising to be sure all specifications are complete and will result in what is wanted. This means some lead time between putting contract together and advertising.

3. Time on helicopters should be by meter readings after the meters are properly checked out. All time on fires in R-6 is kept by meter readings. This will avoid many arguments over differences between clock time and meter time.

4. Plans should be made in advance to provide for dust abatement on helispots in dusty conditions. Operating helicopters in extremely dusty conditions can be dangerous to the helicopter operation, especially where large, turbine-powered helicopters are used.

5. Guaranteed hours on contracts should be as close to the actual hours to be flown as possible in order to reduce bid prices. Low guarantees tend to increase bid prices.

6. Contracts for aerial application should require operator to furnish spare equipment for all parts that are likely to fail including both helicopter and mixing equipment. This should reduce lost time due to equipment failures.

7. All spray and mixing equipment should be pressure tested before it is accepted for the project.

8. Whenever possible, more time should be allowed for location of plots. When plot location is rushed, it often results in plots that are nontypical or are poorly located.

9. As much time as possible should be allowed for training sampling crews. In order to provide for turnover of sampling crews, consideration should be given to a full-time training officer.

10. The project director should be on the job early in the project to be sure all phases of the project are adequately coordinated from the beginning.

11. One man should be assigned to get vehicles taken care of each night to reduce time lost by crews in having vehicles serviced.

12. Helicopters should be equipped with pressure gauges installed on the spray boom in such a location that they can be readily checked by someone besides the pilot.

13. Personnel from different agencies should not be used on the same crews, if it can be avoided. Differences in wages and per diem rates for the same job cause morale problems.

14. An outline of information to be included in the final report should be prepared before the project begins so that all pertinent data can be gathered.

15. Vehicles in poor condition should not be used on the project. From the standpoint of time lost, it would be better to double up if necessary than to have vehicles break down during vital work.

16. A contracting specialist should be assigned to the project on the ground to handle complex contracting problems.

17. An adequate number of good quality stop watches should be provided for keeping time on helicopters, if time is to be kept as the basis for payment.

18. Since communications is such an important part of any spray operation, every effort should be made to provide an adequate number of radios to provide proper communications.

19. Purchasing authority should be obtained early enough in the project to allow adequate time for receiving orders of supplies and materials through regular sources without having to purchase from expensive open market sources.

20. Drop trays with cloth bottoms should be used since those with plastic bottoms did not hold up well.

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APPENDIX

ORGANIZATION CHART
1973 COOPERATIVE TESTS OF CHEMICAL INSECTICIDES FOR CONTROL OF THE DOUGLAS-FIR TUSSOCK MOTH

PROJECT DIRECTOR
J. Mounts

STUDY PLANS
C. Williams, Leader
G. Markin
D. McComb
L. Kline
R. Johnsey

STEERING COMMITTEE
D. Graham, Chairman
A. Larsen
D. Hopkins
D. Lynch
K. Wright

DATA HANDLING
Collection
Handling
Storage
General Analyses
T. Gregg

ENVIRONMENTAL MONITORING
Ore. Dept. Env. Quality
Ore. Game Commission
Ore. Board of Health
Bur. Sports Fisheries & Wildlife
Wash. State Agencies,
Hugh Black, Coordinator

AIR OPERATIONS
Eldon Downs (R-4)

INFORMATION & EDUCATION
Ray Steiger

SAFETY
Ray Gillory

TECHNICAL CONSULTANT
Plot layout
Populations sampling
Detailed specialized analyses
Effectiveness Determinations

C. Williams (IEP)[1]

TECHNICAL CONSULTANT
Formulations
Aerial application
Deposit assessment
Detailed specialized analyses

G. Markin (AAP)[2]

ZECTRAN TEST
D. McComb, Supvr.
E. Collard, Asst.
J. Sater, Asst.
9 Evaluators
2 Deposit Checkers
2 Helispot Mgrs.
4 Weathermen
3 Observers

TRICHLORFON TEST
Leroy Kline, Supvr.
Paul Joseph, Asst.
6 Evaluators
2 Deposit Checkers
2 Weathermen
1 Helispot Mgr.

CARBARYL TEST
Galen Trostle, Supvr.
W. Hyde, Asst.
6 Evaluators
2 Deposit Checkers
2 Weathermen
1 Helispot Mgr.

PYRETHROID TEST
Stan Meso, Supvr.
J. Simonson, Asst.
6 Evaluators
2 Deposit Checkers
2 Weathermen
1 Helispot Mgr.

[1] Insecticide Evaluation Project

[2] Aerial Application Project

Table 1.— Acres treated and costs

Acreage	Extended Mexacarbate Test	Mexacarbate Plots	Trichlorfon Plots	Carbaryl Plots	Bioethanomethrin Plots	Totals
Oregon						
Private - Double	35,975					35,975
State - Double	466					466
N.F. - Single	2,000	1,318	893	1,100		5,311
N.F. - Double	23,353	1,420	804			25,577
Subtotal	61,794	2,738	1,697	1,100		67,329
Washington						
Private - Double	1,382					1,382
State - Double	640					640
N.F. - Single					1,549	1,549
N.F. - Double	6,680					6,680
Subtotal	8,702				1,549	10,251
TOTAL ACREAGE SPRAYED	70,496	2,738	1,697	1,100	1,549	77,580
Cost Per Acre*						
Insecticide	$ 1.112	$ 1.130	$ 1.852	0	0	
Mixing and Carrier	.344	.350	.430	.210	0	
Application	1.680	1.530	1.650	4.520[1]	1.230	
Observation	.375	1.190	1.940	2.040	1.400	
Administration	.260	3.750	2.800	4.120	3.890	
Sampling	.190	10.900	6.070	16.870	21.360	
Total Cost/acre	$ 3.961	$18.850	$14.742	$27.760	$27.880	$4.987
TOTAL COST	$550,584	$78,379	$36,869	$30,536	$43,187	$739,555

*Based on single application.
[1]Considerable extra standby helicopter time involved.

Insecticide Contract

Mix, transport and store approximately 50,000 gallons of Zectran at La Grande, Oregon. Contractor to furnish No. 2 fuel oil for mixture and provide 10,000 gallon storage facility at La Grande. Forest Service to furnish Zectran FS-15. This contract was later modified to provide a total of 140,000 gallons of insecticide with 40,000 gallons of storage at Walla Walla, Washington in addition to that at La Grande, Oregon. There was no change in the bid price per gallon for this change item.

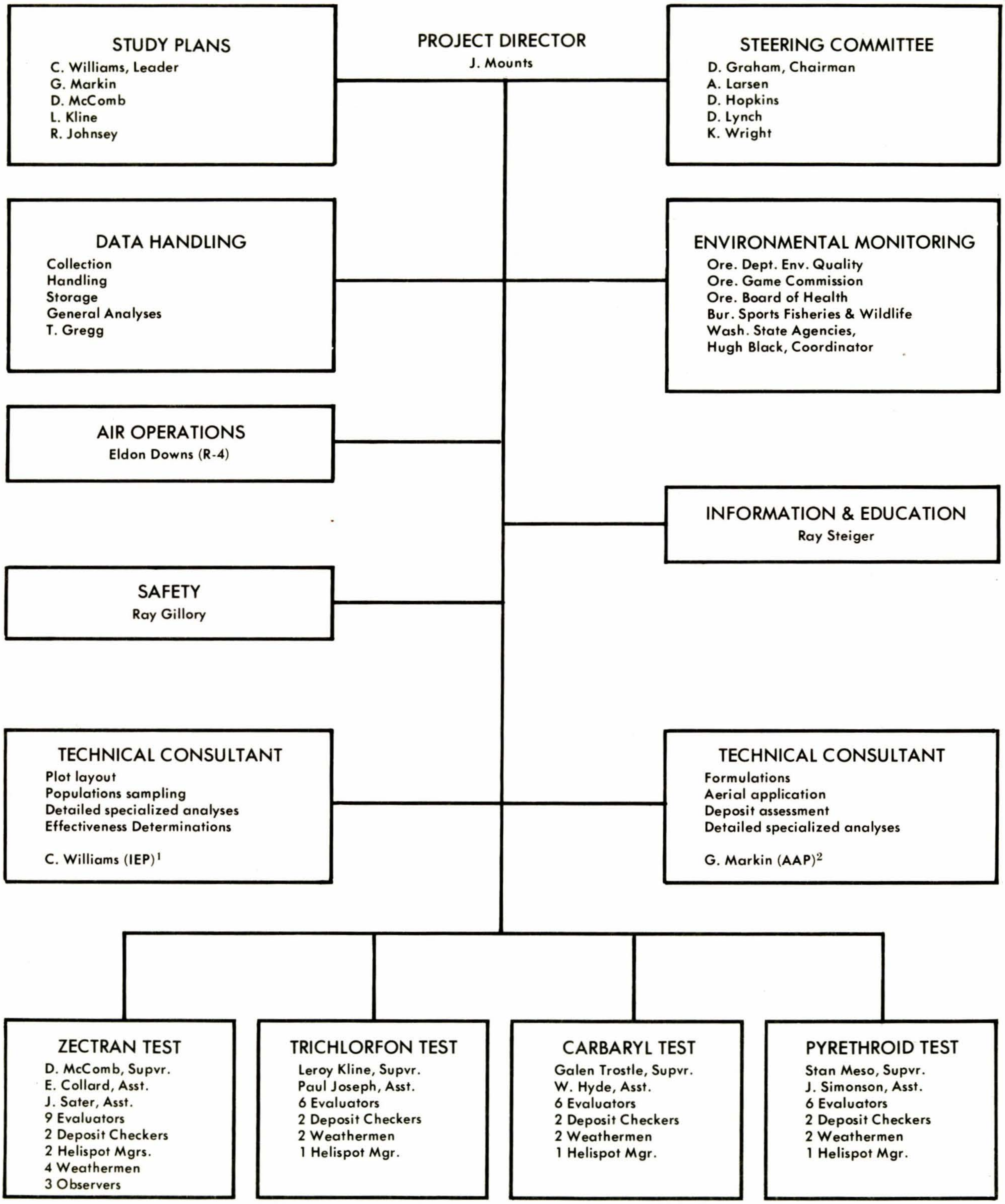
Bidder	Address	Unit Bid Rate	Total
Harbor Distributing Co.	Portland, Oregon	$.349/gal.	$49,181.43

Table 2.— Aerial spraying contract bid rates

Bidder	Address	Type Aircraft	Unit Bid Rate	Total*
Evergreen Helicopters, Inc.	McMinnville, Ore.	Bell 205A	$2,750/hr 1st 20 hrs. $1,400/hr thereafter	$131,273.74
Evergreen Helicopters, Inc.	McMinnville, Ore.	Bell 205A	$1,400/hr thru June 27 $1,200/hr thereafter	$ 78,207.29
Evergreen Helicopters, Inc.	McMinnville, Ore.	Hiller 12E	$350/hr	$ 19,598.50
Mountain Air Helicopters	Salem, Ore.	Bell G3 B-1	$175/hr	$ 4,325.26
Mountain Air Helicopters	Salem, Ore.	Bell G3 B-1	$190/hr	$ 3,590.00
Snake River Helicopters	Pomeroy, Wash.	Bell G3 B-1	$135/hr til July 1 $150/hr thereafter	$ 9,086.50
Helicopters Services, Inc.	Yakima, Wash.	Bell G3 B-1	$225/hr + $200/day	$ 4,973.75
Observation Contract				
Albany Airways	Albany, Ore.	Bell G3 B-1	$135/hr	$ 4,845.75
Grote Aviation	Joseph, Ore.	Bell G3 B-2	$140/hr	$ 10,826.66
Cascade Helicopters	Cashmere, Wash.	Bell G3 B-1	$155/hr	$ 11,301.97
Cascade Helicopters	Cashmere, Wash.	Bell G3 B-1	$165/hr	$ 3,755.50
Evergreen Helicopters, Inc.	McMinnville, Ore.	Hiller 12E	$185/hr	$ 13,672.99
Boise Cascade Corp.	Boise, Idaho	Bell 206B	$200/hr	$ 21,702.00

*Includes standby time @ $200.00/day.

ORGANIZATION CHART
1973 COOPERATIVE TESTS OF CHEMICAL INSECTICIDES
FOR
CONTROL OF THE DOUGLAS-FIR TUSSOCK MOTH



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Application	1.680	1.530	1.650	4.520[1]	1.230	
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Boise Cascade Corp.	Boise, Idaho	Bell 206B	$200/hr	$ 21,702.00

*Includes standby time @ $200.00/day.

Table 7.—Results of the 1973 insecticide tests based on insect mortality

Plot No.	Treatment	Larval Density[1] Prespray	Postspray[2]	Percent Mortality
1	Mexacarbate 1×[3]	92	82	11
4	Mexacarbate 1×	170	74	56
8	Mexacarbate 1×	123	12	90
2	Mexacarbate 2×[4]	152	34	78
5	Mexacarbate 2×	76	18	76
7	Mexacarbate 2×	237	16	93
3	Check	193	175	9
6	Check	24	152	—[5]
9	Check	320	121	62
10	Trichlorfon 1×	163	31	81
13	Trichlorfon 1×	331	24	93
16	Trichlorfon 1×	33	20	39
11	Trichlorfon 2×	210	40	81
14	Trichlorfon 2×	199	15	92
17	Trichlorfon 2×	153	3.4	98
12	Check	524	72	86
15	Check	173	223	—[5]
18	Check	183	136	26
19	BEM 1×	77	97	—[5]
20	BEM 1×	195	102	48
21	BEM 1×	240	40	83
22	Check	11	47	—[5]
23	Check	156	179	—[5]
24	Check	137	77	44
25	Carbaryl 1×	156	31	80
26	Carbaryl 1×	186	39	79
27	Carbaryl 1×	495	48	90
28	Check	64	287	—[5]
29	Check	119	62	47
30	Check	561	73	87

[1]Per 1000 sq. inches of foliage.
[2]Postspray larval density estimates were taken approximately 14 days after the prespray estimates. For single spray plots, the postspray was 10 days after spray. For the double spray plots, the postspray sample was made 4 days after the second application.
[3]Single application of insecticide.
[4]Double application of insecticide.
[5]Population levels increased between pre- and postspray samples - no mortality estimates made.

Table 8.—Summary of deposit data, 1973 insecticide tests based on spray deposit cards, plates, and foliage samples

Plot	Treatment	VMD	GPA Based on Cards & Plates	Drops cm²	μg. A.I.[1] gr. foliage	Estimated GPA[2] Based on Foliage assessment
1	Mexacarbate	118	0.063	14.00	2.308	.096
4	(Zectran)	179	0.191	55.32	7.430	.310
8		184	0.073	34.350	5.858	.245
2(1)		154	0.186	109.12	7.210	.301
2(2)		110	0.224	128.31	11.524	.481
5(1)		130	0.175	67.60	5.112	.214
5(2)		153	0.212	37.32	4.510	.188
7(1)		192	0.152	24.50	8.476	.354
7(2)		180	0.179	14.23	3.895	.163
10	Trichlorfon	359	0.313	8.94	101.815	.638
13	(Dylox)	367	0.264	16.48	64.942	.344
16		362	0.240	14.55	24.614	.154
11(1)		363	0.192	32.55	34.018	.213
11(2)		(rain)	0.193	13.92	74.042	.464
14(1)		301	0.189	36.65	44.891	.281
14(2)		367	0.441	51.00	76.439	.479
17(1)		311	0.117	12.52	17.444	.109
17(2)		326	0.437	29.175	119.636	.750
19	BEM	149	0.100	10.57	1.059	.663
20		185	0.083	4.055	0.347	.217
21		170	0.064	8.700	0.619	.389
25	Carbaryl	156	0.167	20.95	33.872	.212
26		157	0.054	15.80	14.966	.094
27		(rain)	0.063	10.475	26.062	.163

[1]An estimate based on the amount of dye recovered from foliage.
[2]An approximation of equivalent gallons per acre deposit based on Mexacarbate tests in 1972, using a conversion factor of 1 gallon/acre of deposit = 23.932 μg. A.I./gram of foliage.
(Values in parentheses are for first (1) and second (2) application.)

Table 9.—Results of the 1973 insecticide tests based on defoliation data

Plot No.	Treatment	Percent Defoliation[1] Prespray	Percent Defoliation[1] Prepupal Postspray[3]	Percent by Damage Classes[2] Prespray 1	Prespray 2	Prespray 3	Prespray 4	Postspray 1	Postspray 2	Postspray 3	Postspray 4[3]
				5	52	43	-	-	43	57	-
1	Mexacarbate 1×	4.0	99.0	3	20	60	17	-	18	82	-
4	Mexacarbate 1×	5.0	95.0	-	-	100	-	-	2	98	-
8	Mexacarbate 1×	41.0	90.0	10	2	55	33	-	36	64	-
2	Mexacarbate 2×	36.0	86.0	-	-	75	25	-	8	59	33
5	Mexacarbate 2×	24.0	52.0	3	-	73	24	-	-	98	2
7	Mexacarbate 2×	22.0	86.0	-	18	82	-	2	30	68	-
3	Check	0.0	100.0	-	25	75	-	2	45	53	-
6	Check	0.4	100.0	-	5	95	-	5	13	82	-
9	Check	0.0	99.0								
				-	2	20	78	-	23	70	7
10	Trichlorfon 1×	1.4	92.0	-	3	8	89	8	62	25	5
13	Trichlorfon 1×	1.1	83.3	-	-	2	98	2	8	50	40
16	Trichlorfon 1×	0.4	78.4	-	2	73	25	2	33	63	2
11	Trichlorfon 2×	10.4	94.9	-	-	33	67	-	15	55	30
14	Trichlorfon 2×	1.3	78.3	-	5	35	60	3	13	77	7
17	Trichlorfon 2×	1.0	58.8	2	8	65	25	13	45	42	-
12	Check	6.0	99.5	3	5	54	38	20	47	33	-
15	Check	0.5	99.7	5	10	50	35	38	55	7	-
18	Check	2.0	100.0								
				-	4	25	71	10	66	18	6
19	BEM 1×	3.0	94.0	-	12	44	44	4	74	22	-
20	BEM 1×	41.0	100.0	2	12	68	18	2	50	48	-
21	BEM 1×	13.6	99.4	2	-	19	79	10	55	33	2
22	Check	2.0	87.8	-	10	86	4	44	56	-	-
23	Check	35.3	100.0	-	4	34	62	26	64	10	-
24	Check	18.0	94.4								
				-	2	58	40	-	18	80	2
25	Carbaryl 1×	39.7	84.6	-	-	100	-	-	63	37	-
26	Carbaryl 1×	0.0	67.0	-	19	75	6	5	46	49	-
27	Carbaryl 1×	63.1	99.6	10	7	50	33	-	28	72	-
28	Check	14.0	100.0	-	-	45	55	2	85	13	-
29	Check	13.0	99.8	2	43	48	7	25	58	17	-
30	Check	11.5	100.0								

[1]Data reflects the percent of new shoots (or growth) with more than 25 percent *of the needles* damaged by tussock moth larvae.

[2]Damage classes reflect changes in sample trees between prespray and postspray samples (1 = tree more than 50 percent defoliated, 2 = tree less than 50 percent defoliated, 3 = visible defoliation, 4 = no visible defoliation).

[3]Data collected 28-44 days after treatment.

Table 10.—Summary of 4-day postspray larval mortality and spray deposit data for 1973 insecticide test

Plots	Treatment	Percent Mortality (4-day post)	Spray Deposit - GPA Cards & plates	Spray Deposit - GPA Foliage assessment
1	Mexacarbate	-224.8(increase)[1]	.063	.096
4	(Zectran)	27.9	.191	.310
8		61.9	.073	.245
2(1)		62.2	.186	.301
2(2)		58.7	.224	.481
5(1)		35.1	.175	.214
5(2)		64.7	.212	.188
7(1)		66.2	.152	.354
7(2)		46.1	.179	.163
10	Trichlorfon	85.3	.313	.638
13	(Dylox)	79.6	.264	.344
16		47.4	.240	.154
11(1)		57.5	.192	.213
11(2)		71.0	.193	.464
14(1)		45.7	.189	.281
14(2)		93.2	.441	.479
17(1)		45.4	.117	.109
17(2)		95.1	.437	.750
19	Bioethanomethrin	3.9	.100	.663
20	(BEM)	20.0	.083	.217
21		60.8	.064	.389
25	Carbaryl	79.4	.167	.212
26	(Sevin 4-Oil)	71.7	.054	.094
27		67.5	.063	.163

[1]Population increased from 70.2 larvae on prespray sample to 228 larvae on 4-day sample.

Table 11.—Results of the 1973 mexacarbate test based on insect mortality

Plot No.	Treatment	Prespray Larvae per 1000 sq. in. of Foliage	Postspray Larvae per 1000 sq. in. of Foliage	Percent Mortality	No. of Days Between Prespray and Postspray Counts
WW-1	Mexacarbate 2×	116	11	91	22
WW-2	Mexacarbate 2×	377	45	88	20
WW-3	Mexacarbate 2×	66	19	71	24
WW-4	Mexacarbate 2×	40	13	68	23
WW-5	Mexacarbate 2×	108	2	98	21
WW-6	Mexacarbate 2×	59	55	7	19
WW-7	Mexacarbate 2×	134	4	97	20
WW-8	Mexacarbate 2×	278	8	97	19
WW-9	Mexacarbate 2×	61	42	31	20
WW-10	Mexacarbate 2×	123	25	80	23
Perry	Mexacarbate 2×	288	11	96	32
W-1	Mexacarbate 2×	78	55	30	15
W-2	Mexacarbate 2×	114	78	32	13

Table 12.—Results of the 1973 extended mexacarbate test based on defoliation data

	Percent Defoliation[1]		Percent by Damage Classes[2] Prespray				Postspray				No. of Days Between Pre-spray & Post-spray Counts
Plot No.	Prespray	Postspray	1	2	3	4	1	2	3	4	
Perry	5.0	86.4	7	3	90	-	-	3	74	23	32
W-1	11.7	36.4	-	10	70	20	-	3	57	40	15
W-2	15.3	65.4	-	6	54	40	-	4	78	18	13
WW-1	6.2	100.0	13	40	30	17	3	57	40	-	22
WW-3	49.5	98.0	-	-	47	53	-	10	87	3	24
WW-4	23.1	100.0	3	50	37	10	-	50	50	-	23
WW-6	1.8	95.0	-	8	30	62	-	13	74	13	19
WW-8	83.7	100.0	18	18	64	-	28	47	25	-	19

[1]Data reflects the percent of new shoots (or growth) with more than 25 percent *of the needles* damaged by tussock moth larvae.

[2]Damage classes reflect changes in sample trees between prespray and postspray samples (1 = tree more than 50 percent defoliated, 2 = tree less than 50 percent defoliated, 3 = visible defoliation, 4 = no visible defoliation).

Table 13.—Application schedule 1973 insecticide plots

Chemical	Plot No.	Location	No. Applic.	Date of Applic.	County
Mexacarbate	1	T2N, R37E, Sec. 21, 22, 27 & 28	1	6/18	Umatilla
Mexacarbate	4	T2N, R38E, Sec. 19 & 30	1	6/19	Union
Mexacarbate	8	T2N, R38E, Sec. 33 & T1N, R38E, Sec. 4	1	6/19	Union
Mexacarbate	5	T1N, R38E, Sec. 17 & 18	2	6/11 6/23	Union
Mexacarbate	2	T1N, R39E, Sec. 6 - T2N, R39E, Sec. 31	2	6/24 6/12	Union
Mexacarbate	7	T5N, R41E, Sec. 2	2	6/16 6/27 6/28	Wallowa
Carbaryl	25	T1N, R37E, Sec. 3 & 4 - T2N, R37E, Sec. 34	1	6/23	Umatilla
Carbaryl	26	T2N, R38E, Sec. 1 & 12	1	6/10	Union
Carbaryl	27	T5N, R42E, Sec. 7, 8, 17 & 18	1	6/9	Wallowa
Trichlorfon	16	T1S, R35E, Sec. 23, 24 & 25	1	6/20	Umatilla
Trichlorfon	10	T1S, R35E, Sec. 12, 13	1	6/24	Umatilla
Trichlorfon	13	T1N, R36E, Sec. 19	1	6/20	Umatilla
Trichlorfon	11	T1S, R35E, Sec. 1	2	6/12 6/25	Umatilla
Trichlorfon	14	T1N, R36E, Sec. 20, 29	2	6/11 6/24	Umatilla
Trichlorfon	17	T1S, R36E, Sec. 21, 22, 27 & 28	2	6/10 6/24	Umatilla
Bioethanomethrin	21	T8N, R40E, Sec. 10, 14 & 15	1	6/21	Columbia (Wash.)
Bioethanomethrin	20	T8N, R40E, Sec. 11 & 12	1	6/22	Columbia (Wash.)
Bioethanomethrin	19	T9N, R42E, Sec. 4	1	6/14	Garfield (Wash.)

Table 14.—Application schedule — 1973 extended mexacarbate test

Area	Location	Date of Application	County
Perry	T2S, R37E	6/5 - 6/22	Union
Mt. Emily	T1S, R38E & T1N, R38E	6/6-7, 6/21-22-25	Union
Howard Butte	T3N, R40E & T3N, R41E	6/9-10-11-12-13-16-19 6/24-25-26-28-29	Wallowa
Galloway Mdws.	T2N, R38 and 39E	6/10, 6/21-23, 7/7	Union
Maxville	T3N & 4N, R42E	6/13-16, 7/2	Wallowa
Lewis Peak (Wash)	T6N & 7N, R38E	6/18 - 6/26	Walla Walla (Wash)
Phillips Creek	T2N, R39E	6/18-20, 6/29-30	Union
Echler Mtn. (Wash)	T9N, R40E	6/19-20, 6/27-28	Columbia (Wash)
Grossman	T4N, R41E	6/19-20, 7/1-3-5	Wallowa
Mottett	T5N, R38 and 39E	6/20-21-23-24, 7/8-9-10-11-12	Umatilla
Tollgate	T4N, R37E	6/23, 7/1-2-3-4-5	Umatilla
Squaw Springs	T6N, R39E	6/26-27-28	Wallowa
Big Meadows	T5N, R38E & T6N R38E	6/29, 7/1-2-3-4-5 7/6-7-8-9	Umatilla
Milkshakes	T6 & 7N, R39E	6/29-30, 7/1-2-4-5 7/7-9	Columbia (Wash)
Green Peak	T7N, R39E	6/30, 7/1-2-5-7-8	Columbia (Wash)
Tiger Creek	T6N, R38E	7/3-4-5, 7/10-11-12	Umatilla

Table 15.—Weather records, mexacarbate plots, extended mexacarbate and carbaryl tests

Date	Area Sprayed	Time of First Observ.	Time of Last Observ.	Aver. Wind Velocity Range	Max. Wind Velocity Range	Temp. Range	Location of Observation	Remarks
June 5	No Spray	0405	0815	2-8	2-10	40-56	Perry	
6	E.Z.	0500	0615	0	0	60-62	1N 39E 28	
6	E.Z.	0715	0800	0-2	0-4	68-70	1N 38E 12	
6	E.Z.	0400	0545	0	0-2	51-53	3S 37E 6	
6	E.Z.	0645	0800	0	0	66-69	1S 38E 28	
7	E.Z.	0615	0710	0-3	0-5	62	1S 38E 16	
9	C.T.-27	0430	0815	0-4	0-6	46-50	5N 42E	Rain 0630 Intermittent
10	E.Z.	0400	0945	0-3	0-10	36-52	Howard Butte	
10	E.Z.	0540	1100	0-2	0-6	33-62	2N 39E 21	Gordon Creek
10	C.T.-26	0430	0900	0-6	0-9	36-60	2N 39E	Carbaryl Test
11	Z-5	0415	0800	0-1	0-4	37-52	1N 38E 17	Zectran Test
12	E.Z.	0430	0930	0-4	0-5	54-64	3N 41E 9	Howard Butte 0730 - Light rain
12	Z-2	0415	0800	0	0-3	56-62	1N 39E 6	Zectran Test
13	E.Z.	0400	0815	0-4	0-6	46-48	Howard Butte	Overcast
13	E.Z.	0500	0915	0-4	0-5	46-57	4N 42E 33	Overcast
15	Z-8	0415	0700	0-2	0-4	40-48	2N 38E 33	Zectran Test Overcast
16	E.Z.	0400	0915	0-6	0-8	39-50	4N 42E 33	0730 - Rain for 50 minutes
16	Z-7	0415	0545	0	0-6	47-50	Zectran Plot	
16	E.Z.	0400	0900	0-3	0-6	38-50	Howard Butte	HP No. 2
18	E.Z.	0600	1330	0-5	2-10	36-68	Plot W-1	0600-0700 Drizzle
18	Z-1	0415	0930	0-3	0-9	34-42	2N 37E 27	Overcast
18	E.Z.	0415	0715	0-3	0-7	37-42	Howard Butte	HP No. 2 Noregaard Ranch
19	E.Z.	0530	0745	0	0	42-50	Plots W3-7	Clear
19	Z-8	0800	0945	1-4	2-6	56-62	2N 38E 33	High Clouds
19	E.Z.	0430	0930	0-6	0-8	35-60	4N 42E 33	HP No. 3
19	Z-4	0430	0730	0-2	0-4	43-52	2N 38E 18 & 19	Clear
19	E.Z.	0515	0930	0-2	0-5	41-58	Howard Butte	HP No. 2 High Clouds
20	E.Z.	0500	0915	0-3	0-6	50-74[1]	Plot W-2	Clear
20	E.Z.	0445	0900	0-1	0-4	54-65	Tollgate	High Clouds
20	E.Z.	0430	0715	0	0	54-59	2N 38E 33	Clear
20	E.Z.	0430	0945	2-5	3-7	50-72	5N 39E 32	Watershed
21	E.Z.	0430	0930	0	0-1	46-71	Galloway Meadows	Partly Cloudy
21	E.Z.	0445	0645	0	0	58-65	Mt. Emily	Private Land

[1]Temperature raised rapidly from last 15-minute reading.
EZ = Extended Mexacarbate Test
CT = Carbaryl Test
Z = Mexacarbate Test

Table 15. Weather records (continued)

Date	Area Sprayed	Time of First Observ.	Time of Last Observ.	Aver. Wind Velocity Range	Max. Wind Velocity Range	Temp. Range	Location of Observation	Remarks
June 22	E.Z.	0445	0630	0-1	0-3	58-61	2S 37E 35	Perry
[1]22	E.Z.	0430	0530	7-10	10-15	68-70	5N 39E Watershed	High Overcast
22	E.Z.	0445	0545	0	-	63-65	Mt. Emily	
22	E.Z.	0415	0715	0-3	0-6	52-56	Tollgate	
23	Z-5	0430	0940	0	0	54-68	Plot No. 5	Zectran Test
23	E.Z.	0430	0745	0-3	0-5	48-54	Watershed 5N 39E	Partly Cloudy
24	E.Z.	0415	0830	0-4	0-5	48-55	Watershed 5N 39E	Strong Wind Aloft - Overcast
24	E.Z.	0430	0830	0-4	0-6	46-54	Howard Butte 3N 41E 19	Fog in low valleys
24	Z-2	0445	0740	0	0	48-56		Zectran Plot
24	E.Z.	0830	1100	0	0	60-70	Galloway Meadows	
25	E.Z.	0445	0655	0	0	58-60	Galloway Meadows	Overcast
25	E.Z.	0430	0815	0-4	0-5	55-58	Howard Butte 3N 41E 19	0630 - Light Rain 0800 - Steady Rain
26	E.Z.	0430	0630	0	0-1	54-57	Howard Butte	Noregaard Ranch Overcast
26	E.Z.	0515	1245	0-4	0-6	57-68	Plot W-1	0545 - 0600 Light Rain
26	E.Z.	0500	1100	0	0	57-69	Galloway Meadows	Overcast
27	E.Z.	0430	0930	0-2	0-3	54-71	Watershed 5N 39E	Clear
27	Z-7	0540	0555	0-1	0-1	55-58	Big Hole Helispot	Zectran Plot
28	E.Z.	0430	0745	0-1	0-3	44-61	Howard Butte	HP No. 2
28	E.Z.	0445	0815	0-3	0-6	55-73	Plot W-2	Scattered Clouds
28	E.Z.	0415	0730	0-5	0-8	48-56	Watershed	Clear
29	E.Z.	0430	0715	0-3	0-5	40-55	Howard Butte	HP No. 2
29	E.Z.	0444	0800	0-4	0-8	41-58	Watershed & State Land	Big Meadow Heliport
30	E.Z.	0430	0750	0-3	0-5	45-53	Dry Creek & Phillips Cr.	Clear
30	E.Z.	0530	0915	0-6	0-10	37-41	Watershed	Gusty Winds
July 1	E.Z.	0430	0800	0-3	0-6	30-48	Howard Butte	HP No. 2
1	E.Z.	0515	1045	0-4	0-6	35-52	Watershed	Clear
2	E.Z.	0430	0830	0-10	0-20	45-60	Howard Butte	HP No. 3
2	E.Z.	0500	0845	0-3	0-5	54-66	Watershed	High Clouds
3	E.Z.	0430	0815	0-1	0-1	50-61	Howard Butte	HP No. 2
3	E.Z.	0530	1015	0-5	0-6	52-65	Watershed	Clear
5	E.Z.	0445	0645	0-1	0-1	50-52	Howard Butte	HP No. 2
4	E.Z.	0615	0845	0-10	0-12	56-60	Watershed	Clear
5	E.Z.	0500	1015	0-5	0-6	48-60	Plot W-1 & Tiger Creek	
7	E.Z.	0445	0730	0	0-1	29-43	Galloway Mdws	Clear
7	E.Z.	0445	0945	0-3	0-5	41-61	Plot W-1	
8	E.Z.	0445	1000	0-5	0-7	47-62	Plot W-1	Clear

[1]No spraying because of high winds.

Table 16.—Bioethanomethrin test

Date	Area Sprayed	Time of First Observ.	Time of Last Observ.	Aver. Wind Velocity Range	Max. Wind Velocity Range	Temp. Range	Location of Observation	Remarks
June 14	BM-19	0800	1445	2-6	5-11	39-56	9N 42E 9	Rain 0800-0830
21	BM-21	0500	0945	0-4	0-9	64-78	9N 40E 9	Scattered Clouds
22	BM-20	0500	0915	0-8	0-10	70-80	8N 40 E 7	Gusty Winds

Table 17.—Trichlorfon (Dylox) test

Date	Area Sprayed	Time of First Observ.	Time of Last Observ.	Aver. Wind Velocity Range	Max. Wind Velocity Range	Temp. Range	Location of Observation	Remarks
June 10	T-17	0415	0900	0-5	0-7	32-5 i	iS 35E 22	Clear
11	T-14	0500	0630	0-4	0-6	44		
12	T-11	0415	0600	0-2	0-4	54-56		Overcast
16	T-13	0430	0445	0-3	0-6	38		Raining
20	T-16	0645	0900	0-3	0-3	54-68		Clear
24	T-14	1215	1410	0-6	0-10	63-66		Overcast
24	T-17	0530	0815	0-4	0-4	45-58		Overcast

Table 18.—1973 insecticide tests - egg mass density summary

	Plot No.	Treatment Code[1]	-Prespray- Egg Masses Per 1,000 in.^{2}	-Postspray- Egg Masses Per 1,000 in.^{2}
Mexacarbate	1	1-A	13.46	.08
	2	2-A	3.64	.06
	3	7-A	3.30	.05
	4	1-B	7.83	.26
	5	2-B	6.39	.03
	6	7-B	7.20	.20
	7	2-C	2.79	.00
	8	1-C	4.44	.01
	9	7-C	20.96	.27
Trichlorfon	10	1-A	1.90	.42
	11	2-A	3.36	.20
	12	7-A	6.77	.50
	13	1-B	4.33	4.95
	14	2-B	5.80	.06
	15	7-B	7.02	.64
	16	1-C	3.06	.32
	17	2-C	1.99	.03
	18	7-C	3.03	1.70
Bioethano-methrin	19	1-A	4.62	.09
	20	1-B	4.45	.01
	21	1-C	5.59	.03
	22	7-A	1.88	.37
	23	7-B	3.45	.21
	24	7-C	3.02	.03
Carbaryl	25	1-A	5.76	.02
	26	1-B	4.24	.00
	27	1-C	[2]	.00+
	28	7-A	2.17	.00
	29	7-B	1.29	.06
	30	7-C	3.91	.01

[1]Treatment code: 1, one treatment; 2, double treatment; 7, control; ABC, replications.
[2]Egg mass data for plot 27 was lost, however, the test supervisor indicates the egg mass density for plot 27 exceeded the minimal criteria of 1 egg mass per 1,000 square inches of foliage.

Table 19.—1973 insecticide tests - egg mass parasitization data

	Plot No.	No. of Egg Masses Telenomus	Parasitized Trichogramma	Egg Masses Sampled	% of Egg Masses Parasitized[1]
Mexacarbate	1	23	0	25	92
	2	22	1	25	92
	3	20	0	23	86.9
	4	25	0	25	100
	5	24	0	25	96
	5'	20	0	21	95.2
	6	25	0	25	100
	6'	22	0	23	95.6
	7	15	0	18	83.3
	8	25	0	25	100
	9	23	0	24	95.8
Trichlorfon	10	22	0	24	91.6
	11	18	0	24	75
	12	11	0	25	44
	13	13	0	25	52
	14	22	0	25	88
	15	20	0	24	83.3
	16	14	0	24	58.3
	17	23	0	23	100
	18	25	0	25	100
Bioethano-methrin	19	22	0	25	88
	20	22	0	22	100
	21	10	2	25	48
	22	25	0	25	100
	23	21	0	23	91.3
	24	17	0	21	80.9
Carbaryl	25	23	0	24	95.8
	26	24	0	25	96
	26'	22	0	22	100
	27	14	6	25	80
	27'	7	0	10	70
	28	22	0	23	95.6
	29	20	0	20	100
	30	22	0	24	91.6
	31	19	0	22	86.3
	Average 18	23	0	25	92

[1]This column indicates the number of egg masses with at least one egg parasitized in each egg mass. It does not reflect egg mass viability in any way.

Table 20.—1973 insecticide tests virus incidence summary

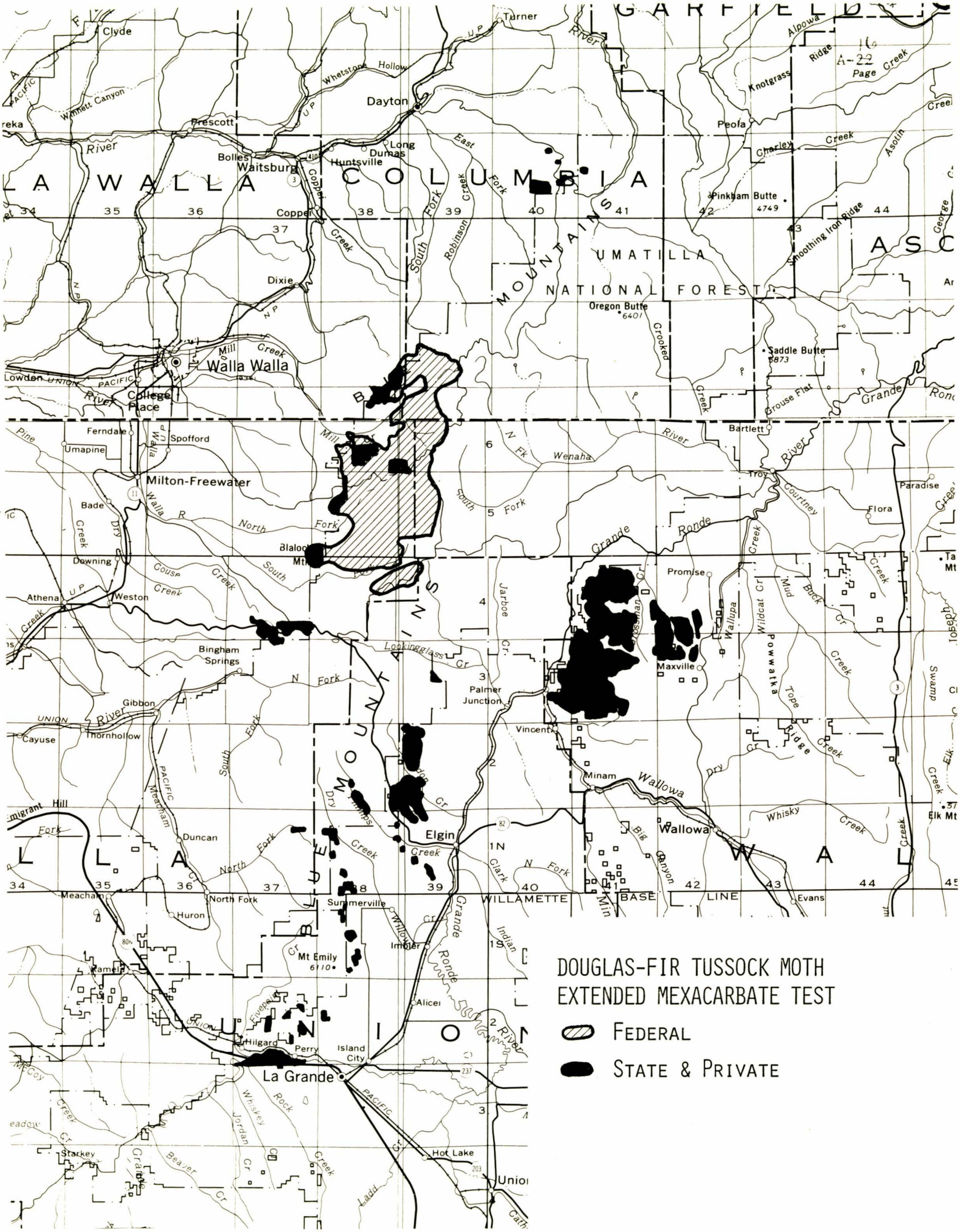
	Plot No.	Def. Class	Masses[3] W/ Virus	No. Larvae Sampled	% Mortality Unknown Causes	%[4] Virus (14 days)
	1	3.00	9/23	1443	5.50	2.30
	2	3.10	3/24	1501	0.87	0.33
	3	3.00	3/22	1464	0.53	0.20
	4	2.75	2/24	1519	4.08	0.20
Mexacarbate	5[1]	3.25	6/43	2501	1.56	0.56
	6[1]	3.00	2/46	2598	2.11	0.08
	7	3.75	3/17	1045	1.11	0.37
	8	3.00	2/25	1442	0.83	0.14
	9	2.95	7/24	1725	2.26	0.64
	10	3.75	1/23	1390	2.73	0.07
	11	3.23	2/24	1528	0.98	0.85
	12	3.28	2/25	1842	1.41	0.22
	13	3.84	0/24	1821	2.70	0.00
Trichlorfon	14	3.68	1/24	1425	4.90	0.91
	15	3.28	1/24	1879	0.69	0.05
	16	3.98	0/24	1773	0.85	0.00
	17	3.31	0/23	1266	2.51	0.00
	18[1]	3.15	3/48	2971	2.42	0.27
	19	3.24	6/24	1319	2.35	0.53
	20	[2]	0/22	1589	0.77	0.00
Bioethano methrin	21	[2]	0/21	1470	2.72	0.00
	22	[2]	3/25	1601	1.88	0.19
	23	[2]	0/21	1368	5.56	0.00
	24	3.58	5/16	1036	1.60	0.66
	25	[2]	0/23	1308	2.06	0.00
	26	3.00	5/46	2653	1.06	1.13
	27[1]	2.83	17/22	1735	4.55	26.80
Carbaryl	28	3.05	1/20	843	4.63	0.12
	29	3.47	1/19	1006	1.29	0.10
	30	[2]	9/24	1292	1.57	3.07
	31	(Discard. C-28)	13/21	1726	4.06	4.69

[1]Two samples taken.
[2]No data taken.
[3]Virus infected egg masses per sample taken.
[4]Percent larvae infected with virus.

Table 21.—1973 insecticide tests virus incidence summary extended mexacarbate test

Plot[1] No.	T	R	S	Def. Class	Egg[3] Mass	%[4] Virus (14 days)
1A	3N	41E	3, 4, 9, 10	[2]	11/24	1.35
1B	4N	41E	16	II	1/25	0.06
1C	4N	41E	36	[2]	0/24	0.00
1D	4N	41E	29	II	1/25	0.05
1E	4N	42E	31	[2]	1/21	0.06
1F	3N	43E	35	[2]	6/24	2.16
1G	3N	42E	4	II	7/24	0.89
1H	2N	43E	4	[2]	0/16	0.00
1I	4N	42E	29	III	2/24	0.28
1J	4N	41E	17	III	2/24	0.13
1K	4N	42E	33	III	1/23	0.06
1L	4N	41E	21	III	2/24	0.14
1M	4N	41E	33	II	1/25	0.06
1N	4N	42E	34	III	1/25	0.06
1O	3N	41E	21	[2]	1/9	0.24

[1]Plots taken on Boise Cascade Corp. Lands.
[2]No data available.
[3]Infected egg masses per sample taken.
[4]Percent virus infected larvae.


16
A-22
DOUGLAS-FIR TUSSOCK MOTH
EXTENDED MEXACARBATE TEST
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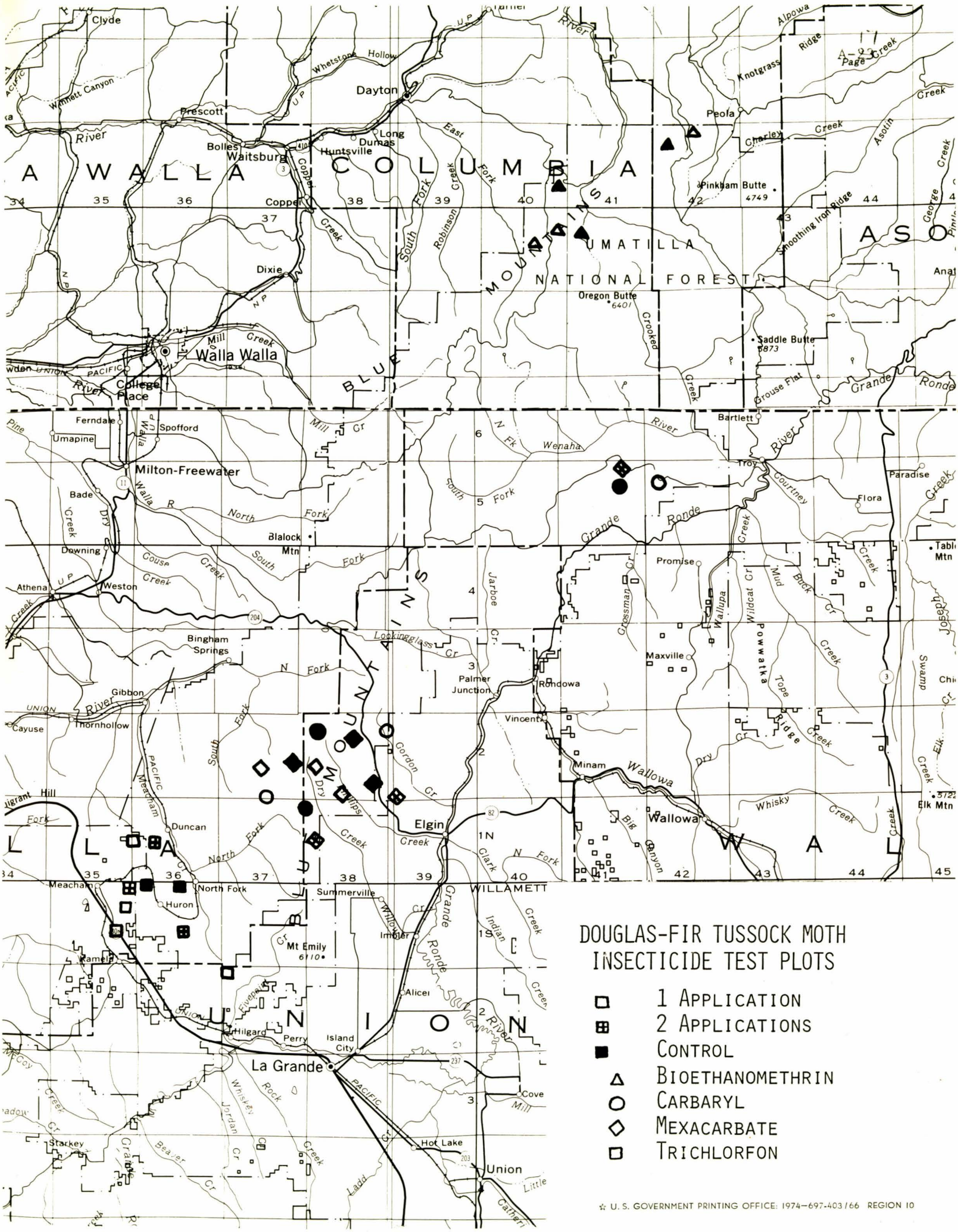
STATE & PRIVATE
UMATILLA NATIONAL FOREST
BLUE MOUNTAINS
COLUMBIA
WALLA WALLA
UNION
WALLOWA
GARFIELD
Walla Walla
College Place
Milton-Freewater
Dayton
Waitsburg
Prescott
Dixie
Athena
Weston
Elgin
La Grande
Island City
Summerville
Imbler
Alicel
Hilgard
Perry
Meacham
Kamela
Starkey
Hot Lake
Union
Minam
Wallowa
Troy
Flora
Promise
Maxville
Palmer Junction
Vincent
Oregon Butte 6401
Saddle Butte 5873
Pinkham Butte 4749
Mt Emily 6110
WILLAMETTE BASE LINE



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